THE SHOOTER'S CORNER

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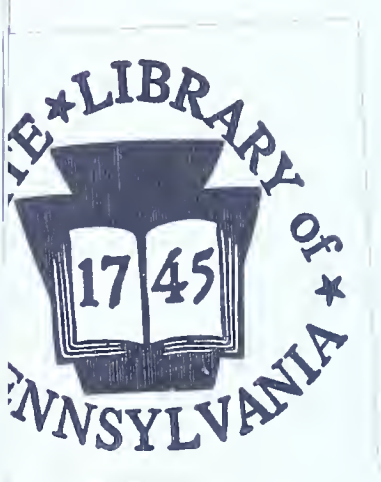
For 25 years, I have written a gun column called "Shooter's Corner" for *Pennsylvania Game News* magazine. It might seem odd to use the same title for a book published by the Pennsylvania Game Commission. However, it is not a compilation of *Game News* columns; it's written in the same style, but has a more comprehensive approach. *Shooter's Corner* is a reference book. It covers a wide array of shooting, hunting and ballistic subjects every hunter and shooter deals with.

During the two years I worked on the book, an honest attempt was made to make it informative, factual, and easy to read. Within its covers, there is something for the veteran as well as the beginner.

I did not write it from an expert's viewpoint. It is written from a hunter's point of view, for you see, that's exactly what I am. All my life, I have been a hunter. I did my best to not make the book highly technical or profound, for I am neither highly technical nor profound. For the most part, its contents derived from my own experiences over a 50-year span of hunting and shooting, including more than 25 years of gun testing and range work.

When I opened my first gunshop after World War II, I never dreamed I was actually on the road to becoming a gun writer. I had an insatiable appetite for ballistics, and I consumed a half-dozen gun magazines every month. Some of the things I read made me feel the reader was not getting sound advice. The desire to write kept building up in me. Still I enjoyed repairing guns, and sighting in hundreds of rifles was sheer pleasure. It seemed I had the world by the tail. But fate would intervene.

The call of the typewriter was strong, and I finally closed the shop and range to the public and started a new career. *Shooter's Corner* is the product of those



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The Shooter's Corner

THE SHOOTER'S CORNER

DON LEWIS

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DANIEL R. LEWIS
1908 — 1960

Plagued with a defective heart from birth, Dan never enjoyed a well day in his life. While he was constantly short of breath, his indomitable spirit and passion for the woods and fields pushed him to the limit of his physical capacities. He was an avid small game hunter, and was exceptionally quick with his 16-gauge Crescent double on grouse.

He was knowledgeable about nature and her diversified residents, and showed me how to read their signs printed in the leaves, dirt and snow. He taught me how to hunt and shoot. Dan truly was my mentor, and I owe him this dedication.

Don Lewis

March 1, 1989

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BOB MITCHELL

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I am deeply grateful to all of them for their help and friendship.

— D.L.

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Don Lewis, the man and the gun.

Tribute to Helen

HELEN AND I were married at Fort Benjamin Harrison, Indiana, in December 1942. Shortly afterwards, I was sent to the Army Advanced Finance School at Wake Forest College, which at that time was in Wake Forest, North Carolina. Helen joined me later, but I was sent to Camp Maxey, Texas, immediately after finishing school. Two months later, another transfer made me part of the Finance Office of the 42nd Infantry Division (Rainbow Division) at Camp Gruber, Oklahoma.

We spent some time together while I was on this side of the ocean, but we didn't get settled into life until late 1947 when we purchased a home and started a family.

I had known Helen for about a year before leaving for the military, and we spent the summer months on the Allegheny River near Hooks Station in Armstrong County. When we weren't fishing or swimming, we were hunting woodchucks. The first gift I gave Helen was a Remington Model 511 Scoremaster 22 rimfire bolt action repeater. It was our constant companion. We spent hours trolling for bass and watching the river bank for chucks.

Both of us were avid woodchuck hunters, but after the children — Carol, Darrel and Tim — entered the scene, she curtailed her chuck hunting. She felt strongly about the responsibilities of motherhood. Helen has strong spiritual and moral philosophies. She didn't get back to hunting until Tim, the youngest, was well through grade school, and then it was just on the local level.

Being home didn't stop Helen from helping in the gunshop and testing handloads at the benchrest. She has always been a super offhand shot and nailed plenty of chucks at 200-plus yards from a standing position, and that's good shooting with a 10-pound varmint rifle. A good many fellows we hunted with will attest to her offhand shooting skills. I never could beat her

Helen and I have been married since the early '40s, and except for my time in the service have been together constantly. She is an excellent shot, particularly on woodchucks and squirrels.

in the field, and I was always hard pressed to print smaller groups with varmint-type rifles from a benchrest.

Several amusing incidents will add a little credence to my claims of Helen's shooting skills. When Helen lived along the Allegheny River at Hooks Station, yacht owners from Pittsburgh would drop anchor there to get fresh water and live bait. Since Helen and I represented backwoods poor folk, some of these affluent souls would go out of their way to impress us with their complete disregard for money, and this cost one yacht owner more than he bargained for.

He kept poking fun at us for being "backwoodsy," and constantly told Helen she should quit hunting and fishing for her meals and move to the big city of Pittsburgh. When he learned the 22 rimfire in our homemade boat was hers, he laughed uproariously. He teased her about not being able to shoot, since shooting was a male sport. To prove that she couldn't hit the side of a barn, he whipped out a gold pocket watch and hung it on a stump some 40 yards away. With somewhat of a gracious bow, he invited her to show him what she could do. Helen was understandably apprehensive about shooting at a real watch, but I told her quietly to shut the fellow up once and for all.

The owner's wife was noticeably upset that he was so careless with his birthday gift from her, but he assured her that, at that distance, there was no

danger. He said since it didn't look like a squirrel's head, Helen wouldn't think she was out getting breakfast. A wide smile crossed his face as Helen dropped to a kneeling position, and there was complete silence while she aimed and fired. The watch seemed to disintegrate when the hollow point bullet hit it, and I still remember the distinct sound of a spring or wheel whining away through the air. As we rowed away, there were positive sounds of a domestic problem on shore. His plaintive "How did I know she was an Annie Oakley?" has stuck in my memory through all the years since.

Another incident involved a rather profane chuck hunter. He brought a heavy barrel 22 Varminter (now Remington 22-250) built on a Mauser action, complete with set triggers, to have a new scope mount setup installed. He wanted the Varminter zeroed in one inch high at 100 yards. According to him, this rifle was the best chuck outfit east of the Mississippi, and he claimed he could cut less than half-inch 5-shot groups at a 100 yards when he used his own handloads. They happened to be the best on both sides of the Mississippi.

Surprisingly, the rifle was super accurate, and I shot several 3-shot cloverleafs one inch above the centerline of the bullseye. I wasn't home when he picked up the rifle, but Helen said the hunter was explicit, with expletives, about why he needed the rifle shot in precisely. He was on a string of 11 straight 200-yard kills, and was heading for a grand total of 25.

The next day the phone in my office rang, and the tone of Helen's voice told me instantly something was wrong. She didn't sound scared, but very irritated. The guy with the Varminter was back, angrier than ever and raking me up one side and down the other. He had missed an "easy" 275-yard shot twice, and he knew definitely something was wrong with the sight-in. For more proof the rifle was off, his brother-in-law had fired three shots from the sitting position at about 80 yards. He claimed the group looked like a shotgun pattern. He wanted me to come right home and check the rifle while he watched.

I had some suspicions about this fellow's shooting ability, and the fact that he didn't know how to zero in his own rifle made me more dubious. I was really tied up and told Helen to fire a 3-shot group from the bench and call me back. I later learned that as they walked to the bench, he griped about having a "woman" check out his rifle. This was certainly inappropriate, and embarrassed and angered her.

A half-hour later Helen called to tell me everything was in order. When I asked what had happened. she told me she had put 3 shots in less than the diameter of "his" nickel, about a half-inch above the one-inch square target.

The fellow was flabbergasted. In a surly manner, he told her he still

thought something was wrong. "There is," she told him. "You don't know how to shoot."

Helen and I spent a lot of evenings together in my little reloading shop. She enjoyed dumping powder charges and seating bullets. She also took an avid interest in bench shooting, and she did a lot of shooting for me when I had the sight-in range. In fact, several customers from the '60s still bring their rifles for her to "tune."

Helen was an avid photographer even when she had nothing more than a simple box camera. When she started taking photos for my gun articles many years ago, she used a camera I had won in a sales contest. It was plastic and probably carried a price tag of less than $20.

Since 1965, Helen has used a variety of cameras, from a Mamiya Twin Lens to an EOS 620 Canon. (You can do this when your daughter owns a camera store.) Her favorite outfit of all times is a rather old Canon F-1 that has taken thousands of photos, including the one on the front cover of this book's dust jacket. Most of her black-and-white closeups are taken with a Mamiya Twin Lens that allows her to focus down to around a foot, although the EOS Canon 620 has a macro setting for very close shooting.

Helen's passion for photography fitted right into the scheme of things. She could kill two birds with one stone: hunt and still take pictures. I benefitted from this arrangement because most of her photos could be used for future gun articles. Helen has learned her trade rather well. She is capable of taking an action picture of a ringneck rooster exploding out of a weed patch or making a setup to photograph the crater formed when excessive chamber pressure wraps the primer metal around the firing pin.

Nearly forty-seven years ago, we started as a team, and we still are a team. It hasn't always been a bed of roses. We have had our share of life's realities, and have stood on the brightest hilltops and in the darkest valleys, but these are the ingredients necessary to solidify a marriage and make it possible to face the vicissitudes of life. I believe we still have a deep and abiding faith in each other. When we started the gun writing/photography venture, we had nothing but intestinal fortitude, but things turned out pretty well.

Helen is a talented person, not only in photography and shooting, but also music. She plays an electric organ very well. Her creative input over the decades was not only important but substantial. I'm positive that without her encouragement and sharing of responsibilities, this book would not have come to fruition. I'm most fortunate to have a shooting partner who is highly competent and also very attractive.

How I Got Started

WHEN I READ an interesting gun book, I get a strong desire to know more about its author. Questions keep infiltrating my mind. It's not that I doubt the authenticity of the contents nor am I challenging the author's credentials; I would simply like to have more information on him. That is, more than just a listing of his achievements in the academic and literary categories. I want to know something of his personal background. Assuming others might feel that way, I'll give some background on myself.

Somewhere along the line, I was introduced to the shooting and hunting realm. Something eventually steered me into the gunwriting field. There had to be small personal incidents in early life that stimulated my desire for guns and my interest in hunting and even writing. It's hard to recall all of the details.

But now that I have picked up the author's pen, I'm faced with trying to answer such questions. The shoe is on the other foot, so to speak. I can assure you nothing startling will be uncovered, nor will these revelations bring to light the proverbial Horatio Alger-type success story. Nothing could be further from the truth. Still, there will be evidence that what I am doing now actually started very early in life.

In 1927, when I was 6, my family moved to a crossroad hamlet called French's Corners which, by the way, had a mailing address of Adrian. Now, the Adrian post office was smack in the middle of a village called Montgomeryville. I know this is confusing, and I spent almost four years in the Army trying to explain this situation to fellows from Chicago, New York and San Francisco who thought a mailing address named the town you lived in. They were even more befuddled when they learned I started first grade in Township School Number 3 which was called Centerpoint, but the centerpoint of what?

For many youngsters, their most unforgettable Christmas gift has been a gun. Our youngest son Tim was ecstatic over his Ithaca 22 single shot.

Life in the back country during the early 1930s was relatively simple. Most of the roads were unpaved, which meant putting the car (for the affluent) in the garage in November and relying on horse power or train service through the winter months. The Great Depression was in full swing, and eking out a living was the basic concern. This was accomplished by doing any type of work available and owning a cow, several hogs and a flock of chickens. These, along with a large garden and success during berry picking and canning seasons, kept food on the table. Hunting season also played an important role in the food chain. Everything from quail to deer was consumed. Many times when the temperature was below freezing, a dozen or so skinned rabbits and squirrels would be hanging on the back porch. We never went hungry.

Still, there was ample time for other activities such as reading and trapping, and I did my share of both. I roamed the hills and woods around home, and by the time I was 10 knew the name of every hill, vale and creek within a five-mile radius. In the midst of the Depression, twin brothers Ray and Roy Johns and I trapped weasels during the summer for the dollar bounty Pennsylvania then paid for each hide. It was our only sure way to get money for a license and shells for the November small game season. When I found a weasel hotspot, it wasn't uncommon for me to wear a miner's carbide lamp and run the trapline around midnight. Now and then fortune smiled and the early visit would produce a weasel. On rare occasions, the same trap would have another weasel on the morning run. Believe me, life wasn't a gravy train back then.

My only sister Marjorie married in the early 1920s, but my three brothers lived at home until they married in the mid-1930s. Cull taught school and Fred did clerical work for many years. For a number of years before his death, Fred owned a grocery store in French's Corners. Dan was plagued with an incurable heart problem. He never knew what the next day would

bring. He worked at odd jobs until after his marriage, when he became a justice of the peace. The magistrate's position was ideal as it allowed him to work out of his home at his own pace. Dan spent much of his time reading or in the woods. His passion for hunting, shooting and trapping made a great influence on me. Dan and I spent hundreds of hours together. On the trapline, I lugged the equipment and Dan furnished the technical knowledge. When we hunted, he would stand on a log or rock while I tramped the brush around him. Small game was fairly plentiful, and our system paid off dozens of times. He was a good shot and seldom missed.

Cull and Fred were fine hunters, but it was Dan who instilled in me a deep love and respect for nature. He was a good teacher, and what he learned from experience and reading, he passed on to me. He didn't have the physical strength to be the typical more powerful older brother; his pleasure in life came from helping me and other youngsters more deeply appreciate nature and her creatures. I have never forgotten his contribution, and that's why this book is dedicated to him.

I came from a home that overflowed with books. Every member of the family was an avid reader. I don't know how many books we had, but bookcases filled the basement, lined every room downstairs, went up the stairway, and covered at least two walls of each of the four bedrooms. When electric power came our way and a bathroom was installed, it boasted a large bookcase. I'm sure we had more than 5000 books, and I vividly recall sitting around our kitchen table flooded with light from an oil-fed Aladdin lamp, the entire family eating homemade donuts and drinking hot coffee while mother read aloud. She and my oldest brother, Cull, were skilled readers. They had excellent diction and expression that captured the attention of every listener. It wasn't uncommon to find a couple of neighbor boys buried somewhere in the circle. Reading was a way of life with the Lewis family.

Maybe writing was an innate talent in my family. My mother wrote many poems and short articles for religious publications, and my dad contributed to several chicken-fighting magazines. He had his own bloodline of game chickens, although he did not participate in the fight game. When family members weren't curled up on the couch or sunk in an overstuffed armchair with a book, they were cranking out letters which were read aloud for family approval. By the time all the off-the-cuff suggestions were incorporated into the letter, it required two stamps to send it. Even at a mere two cents per stamp, the family budget was hard pressed to meet the letter-writing skills of my clan.

During my sophomore year in high school I was hit with the writing fever. World history was a favorite subject of the entire family (our home library

This was a corner of my loading shop, just after WWII. Tool is an early Herter's turret head. I loaded many thousands of cartridges on it.

had at least 500 history books), and when an aging history teacher announced a contest for her four classes, I was determined to win. The top three entries would be displayed for several weeks in a local store window. Number one would be in the center with a gold ribbon on it; the runners-up would get stickers and honorable mention. I put everything I had into my essay.

Three weeks later I learned through the grapevine that my entry had won. But my joy was short-lived for my credibility was being challenged.

Several days later on the way to school, I mixed in with a group of students in front of the store window, and what I saw made my heart sink. My article was there, but it didn't have a ribbon, just a second-place sticker. Several snide remarks about cheating cut me deeply, but all I could do was swallow my pride and walk away. I didn't have the nerve to ask the teacher if I had originally won first place or not.

The rumor mill finally got the story to me. A tall lanky kid I had exchanged blows with at the train station had gone to the history teacher and told her that my brother was not only a schoolteacher but also a history expert. The student said he knew for certain my brother had practically written my thesis. She was caught between a rock and a hard place and probably had no choice but to drop me to second place.

It was true my brother Cull was a teacher and well versed in history. It was also true he had helped me find research material. However, he did not write the essay. But such is life. I'm happy to report that not all was lost.

From that moment on, I wrote short stories and even put out a small weekly newspaper (circulation one) called the "Daily Blab." Don't ask me to explain how a weekly was called the "Daily Blab." It was hand-printed by yours truly with actual photographs glued to the front page.

Even though I didn't like school, the thought of becoming a writer was imbedded in my makeup. Yet, it would be many years before I saw my byline in print.

All through my early years, I practically lived with a 22 rifle in my hands. I was a constant reader of gun and trapping publications. But it never occurred to me back then as I leafed through Stoeger's *Shooter's Bible* that I would eventually become a regular contributor to it.

After serving 41 months in the Army during World War II, I came home in 1946 and spent five years or more specializing in woodchuck hunting and collecting varmint rifles. This led to a gunsmithing/reloading shop where many tens of thousands of rounds were cranked out. I had more than fifty sets of reloading dies. Business was so heavy in the late 1950s and early 1960s that I was forced to give up the gunsmithing aspect and concentrate on reloading.

During that same period, scopes were becoming popular with both varmint and big game hunters. Since I had a 100/200-yard range, I began zeroing in rifles. By the mid-'60s handloading equipment had so saturated shooters' ranks that reloading for others was no longer profitable. I switched to personalized scope mounting and sighting in rifles. This continued until the burden of writing on top of a fulltime job forced me to give up the gun shop and concentrate on being a gunwriter.

I enjoyed those years, and I learned a lot. I met hundreds of hunters and shooters who shared their gun knowledge with me. In fact, I have never met anyone from whom I haven't learned something. Also, I'm very much indebted to the thousands of *Pennsylvania Game News* readers who have written to me since I began doing the gun column there in 1965. Their encouragement and helpful suggestions have enhanced my writing career. Without this invaluable help, this book would not have been possible. After all, it is a product of all these things plus a long shooting career.

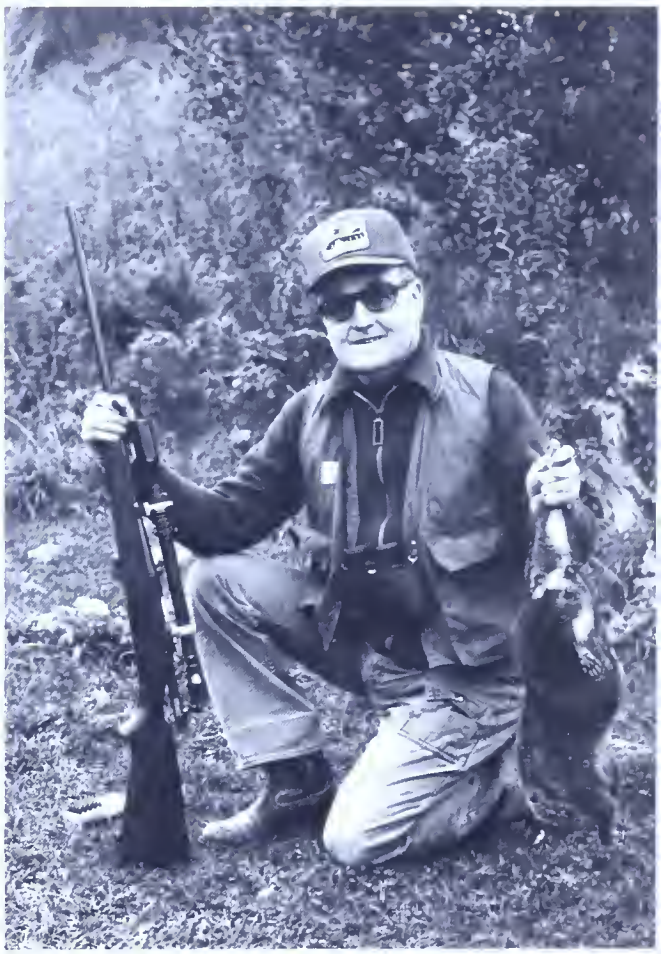
The Post-World War II Years

I SUPPOSE COUNTLESS soldiers, like myself, dreamed of getting back to the rabbit patches, pasture fields and deer woods when they were handed their military discharge papers. Never in our wildest dreams did we think the shooting fraternity was about to undergo a change that would usher in a complete new approach to shooting and hunting. A small 224-caliber centerfire cartridge and a simple ammunition reloading press brought about this significant transition.

I was discharged from the Army in March 1946. Work was scarce, and I spent most of the summer doing odd jobs and hunting woodchucks with a Remington 511 Scoremaster rimfire 22. For several more years I hunted them with a variety of centerfires, and then in 1949 I purchased a Winchester Model 43 chambered for the 22 Hornet cartridge and installed a battered Mossberg scope. To be honest, I can't recall the model, but it probably was Mossberg's old RF1, or it could have been their Model 5M4. It makes little difference now; the scope had seen its better days and the next spring I traded it and the rifle on a used Remington 222 topped with an 8x Unertl Varmint scope. From that day on, my whole philosophy on both chuck hunting and shooting changed.

I have to step back to around 1948 to set the scene for my introduction to handloading. I had read plenty about the subject, a scant amount even before Wold War II, but handloading actually seemed like a waste of time and effort to me. Especially when fine quality factory loads were as near as the local grocery store.

My usual routine was to buy one box of low brass Peters Victor and another of Peters High Velocity high brass shotshells before each small game season. Even after the war, most hunters, myself included, knew very little about the ballistic makeup of a shotshell. We believed that lowbrass meant



In the late '40s I shot chucks with several rifles with only ordinary success. Then I traded for this M722 Remington 222 and 8x Unertl scope. This outfit changed my whole philosophy on chuck hunting and shooting.

low power and high brass meant full power. In other words, we thought a high brass shotshell had far more velocity than a low brass. One kid I hunted with wouldn't touch a low brass shell; he used high brass for "reaching out." We know now that high or low brass is not an indication of power. Generally speaking, a high brass shell has a low base inner wad. The high brass band fully encloses the relatively weak area where the case walls meet the base wad. Conversely, a low brass shell has a high base wad. The high wad is used to reduce case volume and adapt it better to its lighter charge.

It is true that low brass factory loads usually have lighter shot and powder charges. However, it's not true that the high brass shotshell has a higher velocity reading. One day back then I checked an old Stoeger's 1931-32 "Arms and Ammunition" catalog, and was surprised to learn that a Peter's Victor 20-gauge low brass shell had a 7/8-oz. shot charge and a 2 1/4 dram powder equivalent with all shot charges listed, while the Peters High Velocity high brass 20 had the same powder equivalent behind 1 oz. of shot. No velocity readings were shown, but I had a strong feeling that any velocity difference between those two shotshells would be minimal.

Down through the years I hunted, prior to my induction into the military, it never occurred to me to reload a shell. Both shotgun and centerfire rifle empties were left where ejected. I could almost tell who had been in an area by the color of the shotshell empties I found.

During the fall of 1948, I was shopping for a chuck rifle for the next summer. A crowd was gathered around a table, and I could hear someone

making a sales pitch about reloading your own ammo. When nothing in the rack appealed to me, I stopped to watch the reloading demonstration. For the life of me, I can't remember the names of the tools being used, but it dawned on me that handloading was definitely not a waste of time.

After the crowd had gone, I talked with the operator for over an hour. The Pennsylvania small game season was just days away, so he was pushing a shotshell reloader, but for my benefit he cranked out several 30-30 cartridges on a rifle reloading press. Since I was still using the 22 rimfire for chucks most of the time, a reloading press didn't seem to be a pressing need. However, the next summer, after I had bought the Winchester Model 43 Hornet and got really serious about chuck hunting, it was apparent I could save money by reloading my own ammo. Right then, saving money was the only reason I was interested in handloading.

Forty years later it's difficult for me to come up with the exact date, but it was the second summer I used the Hornet that a hunting buddy and I joined forces in the reloading game. Unfortunately, I didn't have a suitable place for the equipment, so we made a deal that I would buy the gear and he would reload for both of us. Right at that same time, the owner of a sporting goods store told me he was discontinuing his reloading equipment line. This may be hard to believe, but he told me that reloading was too dangerous and would soon die a natural death. Actually, he carried a tremendous inventory of factory ammo, and I think reloading was cutting into his ammo sales. To make a long story short, among other things he had a Tru-Line Jr. reloading press, complete with powder measure and a number of die sets, that he wanted to sell for around $35. I ended up with the press, eight sets of dies, an Ideal powder measure and a Pacific scale. I was still thinking in terms of saving money when I loaded the equipment into my car. It never dawned on me that not only would I save money, but that reloading would change my life.

My friend and I had a cooperative operation for about a year, but it eventually became obvious that too many miles separated us and his work schedule kept him away from the loading bench for long periods. I seemed to be always short of ammo. Since he already had the equipment set up, I sold out to him and built my own reloading shop. At that moment I had no intention of reloading for others. I lived in a very small house, and the tiny shop would be a good place to spend some evenings reloading hundreds of 222 rounds. That's what I had in mind. Fate had other ideas.

I hardly had my new press bolted to a bench when the word got out that Lewis was opening a reloading shop. That wasn't the case, but it didn't deter several dozen newcomers to the varmint ranks from dropping off boxes of

empties. Whether I wanted to be or not, I was in the reloading business. Five years later, I was keeping about 50 sets of dies busy. My normal shop hours began shortly after 6 p.m., and ended when I finished well after midnight.

It's strange how one thing leads to another. During the time I was reloading, I would get a request to mount a scope or zero in a rifle. I wasn't in the reloading game too long until I realized it was necessary for any serious reloader to test his own ammo. Most other reloading buffs were just stuffing cases and pulling triggers. It was a cheap way to shoot. When I came to the conclusion that reloading was more than just saving money, I built a benchrest and constructed a 100-yard range. The benchrest was built from odds and ends of planks that had been part of an old barn. I have no great skills as a carpenter, and a friend who closely inspected my work referred to it as a "carpenter's nightmare."

Be that as it may, it was strong and comfortable. I hadn't fired many groups from the bench before I became interested in developing an accurate load for my 722 Remington. I lost all desire to just reload and shoot. Burning fodder had to have more positive results. I really didn't understand what I was doing, nor was I aware of all the complexities involved in developing an accurate load. After a month of cutting groups, I learned that to develop an accurate load required more than just assembling components into cartridges and shooting. Records had to be more comprehensive than just the sticker on the back of the shell box.

I also soon learned that the quest for accuracy involved more than just altering the weight of the powder charge. During the rest of the summer, I fine-tuned my efforts by using cases of the same weight (heavy cases usually have thicker walls and hold less powder), checking primer pocket diameter and depth, measuring the diameter of the flash hole, thinning and reaming the neck, and having every case the same length. While all that is necessary, other requirements include mating primers with powder charges since each brand of primer can give a different pressure level (it's wise when changing primers to start with the lowest suggested powder charge and work up to avoid pressure problems), checking the volume of powder in the case, and using a bullet that is concentric and has a square base. The last was the most difficult in years gone by.

Even when every step mentioned is taken, results are not instantaneous. The reloaded cartridge will not produce a one-hole group for every shooter or in every rifle. All the time I was reloading and shooting, I was also doing research. Strange that it never occurred to me that the perfect round would only work in the perfect rifle being fired by a perfect shooter. I assumed that when I had all the ingredients right, getting the one-hole groups would be like

stealing candy from a baby. Brother, how wrong was that assumption.

Well, I'll skip over the rest of my quest for accuracy to get back to other things that happened to me during this time period. First, to get a full 100 yards of range, I had to place the benchrest within ten feet of a well-traveled dirt road. This meant that every person who passed could see me shooting. Now and then, someone would stop to watch.

Early one evening, a car stopped and the driver took a gun case from the trunk. Helen and I had agreed not to allow others to shoot from our benchrest. It wasn't that we wanted to be unfriendly; there was a legal factor that had to be considered. I had no insurance (maybe couldn't have gotten any) in case of an accident. When I saw the fellow approaching with his gun case, my mind started to work overtime trying to figure out exactly what to say without offending someone I didn't know.

"I'd like you to sight my rifle in," he said approaching with an outstretched hand. "I pass here quite often, and you are always shooting. I figured if anyone knew how to help me, it would be you."

"I admit I do a lot of shooting, but it's only with my own varmint rifles," I answered. "I don't sight in rifles for other people."

"Well, at least you know something about shooting, and that's more than I know. In fact, if you can get it on target, it'll be more than a brother-in-law and two neighbors have been able to do. This old Springfield is a mile off."

My varmint scope had dehorned target type adjustable mounts. His scope had internal adjustments. I knew very little about scopes, but I told him if he was willing to furnish the ammo, I would do the shooting. He agreed.

I'm happy to report that we were successful in the end, though it took nearly two boxes of shells to get zeroed. He wasn't a bad shot, and put the last three rounds in a 5-inch bullseye we had drawn on a sheet of paper. I'm not exaggerating when I say he was overjoyed. In fact, he kept the target to "show those dummies what good shooting is all about."

As he was leaving, he stuffed some paper money in my shirt pocket. I told him I didn't want to be paid, but he insisted. I'm not certain now if he left one or two dollars, but I knew it was the easiest money I had earned in a long time. Later, as I wheeled my gear and rifle down the road in a makeshift cart, I started thinking about the possibilities of operating a sight-in range.

I discussed the idea with Helen, and we reached the conclusion that, with my limited facilities (I didn't even own a spotting scope), it wouldn't be a practical venture. We were more or less convinced that relatively few hunters would want someone else to sight in their big game rifles. For the remainder of that summer, the project was put on the back burner.

There often seems to be some incident that rekindles fresh interest in dead

projects. The sight-in range was given new blood when a phone caller asked if I would re-mount five scopes and zero in the rifles. He felt the scopes weren't mounted properly, and he was positive the rifles were not sighted in. He said he had been trying to find a gunsmith who would do the complete job, and his cousin (the man who stuffed the money in my shirt pocket) suggested he get in touch with me. In ending our conversation, he told me he couldn't understand why I didn't advertise, since he knew a dozen hunters who had scope problems and didn't know how to correct them or sight in their rifles.

I felt that was just loose talk to spur me on since I had told him I was more in the reloading business than in mounting scopes and sighting in rifles. But the whole idea appealed to me, and I agreed to take on the job.

My knowledge about scope mounting was limited, but I squared the reticles and adjusted the scopes to give the proper eye relief. I remember that one scope was a 4x Unertl Hawk that moved each crosswire separately. When the rifle was sighted in, the reticle was far offcenter, high in the upper right corner. At that time, I didn't know how to shim the bases to correct that problem.

I shot most of the ammo getting the rifles zeroed, but I taped a target to each rifle to show that the last three shots were in the 5-inch bullseye. Not having a spotting scope forced me to walk down to the target to locate the bullets holes I couldn't see through the scope — which was most of them.

Apparently my work was satisfactory, as those five hunters voiced no complaints and were responsible for sending a half-dozen other hunters to my range. Business didn't boom immediately, but I zeroed in 21 rifles that fall for which I was paid a grand total of $63. I sure didn't make any money, considering the cost of targets plus the fact that I many times used my own reloads to work out a severe problem before using the ammo the shooter furnished. I wanted to learn, and didn't charge for my ammo.

I used most of the $63 to buy an inexpensive spotting scope. It certainly saved a lot of walking. As winter passed I thought more about opening a scope mounting shop complete with a range. One thing stood out like a sore thumb: I knew that the few problems I had encountered working with only 21 scopes were just the tip of the iceberg. Scopes were gaining popularity, but most local gunsmiths had little knowledge of how to mount them. From what I had seen, the scope was centered in the mounting rings, and the crosswire could be anywhere from 5 to 15 degrees off square. I also learned that not one scope had been focused for the eye of the person using it. It became evident that scope mounting and range shooting held a much greater potential than I had realized.

I didn't get carried away with my advertising campaign for the first two years. I was learning fast, but still had many scope mounting problems to encounter. The third year, I placed a small ad in the local paper and a few hand-printed signs in grocery stores and gas stations around the local area. I didn't think anyone would drive more than twenty miles to have me mount a scope or zero in a rifle.

Right from the start, I ran into opposition. The local crowd, and even some of my hunting buddies, had plenty to say about "Dead-eye" Lewis. Sometimes it was hard to take, but I held my peace. One sarcastic fellow turned on me, after he had thoroughly digested my poster listing the prices, and said, "Hey, Lewis, how many deer have you shot?"

"A few," I answered.

"You know how many I've shot in the last twenty years?"

"No."

"Twenty," he fired back. "How come you think you can shoot better than I can?"

"I never said I could."

"Well, you've posted a big sign telling everybody to bring his rifle to your place to have the scope mounted properly and the rifled zeroed in. It sounds to me like nobody else knows how. My nephew helped put mine on, and you won't find a better job. I knocked a running buck for a loop, with just one shot, at close to 200 yards last year. What do you think of that?"

"Sounds like good shooting. But I don't think it necessarily proves your scope was mounted properly. That's a long distance to make an accurate shot on a running deer."

"Well, it might not prove it to you, but it does to me. Tell you what, I'll stop by some evening with my outfit and let you look at a scope that is mounted the way a scope should be mounted. Maybe you'll want to take your advertising down. In fact, if you find anything wrong, I'll be happy to pay you to fix it," he said with a mean grin.

"I'm not saying that most gunsmiths, or even some hunters, don't know how to mount a scope. Maybe you and your nephew could teach me a few things. I'm trying to help those who don't know how."

"And make yourself a bundle," he tossed back.

"If you take a close look at my prices, it will be evident that it will take a long time for me to make a bundle. I'm not rich yet; I'm just trying to drum up some business."

I could see I was getting nowhere, so I left. In fact, I completely forgot about the incident. A week later, I was studying a target through my new spotting scope when a car stopped. I was getting used to people stopping, and

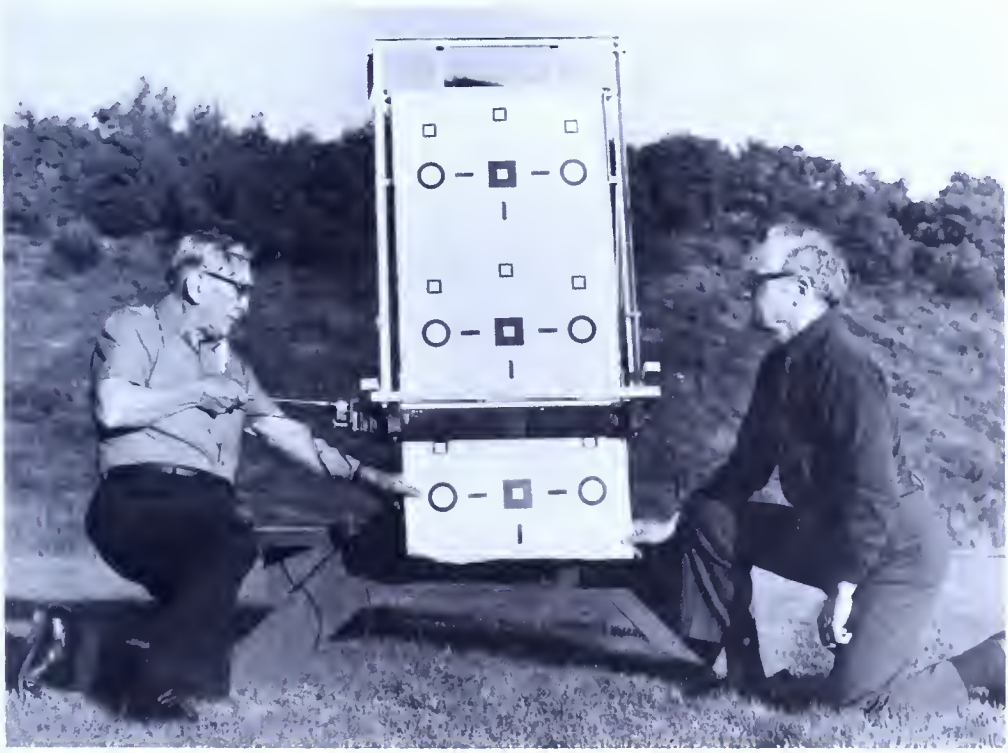
didn't even look up. Believe it or not, it was the man with the perfectly mounted scope.

My first reaction was resentment; I wasn't in the mood to go through another hassle with this fellow. I was somewhat taken back when he simply handed me the rifle with a suggestion that I study the scope mounting job in detail. He said he intended to buy another scope since this one was fogged.

One look told me this man needed help. The scope was pushed way forward in the mounting rings, and the reticle was leaning so far to the right it almost formed an X. Not only that, the reticle was badly out of focus. I really didn't know what to say, but I finally blurted out that maybe the scope wasn't fogged, but just needed to be focused. That suggestion fell on deaf ears, but when I screwed the ocular lens back until the reticle was sharp and the scope was clear, he was at loss for words.

When I won that round, I pointed out the other defects I could see. However, he insisted these so-called flaws didn't mean anything. To prove the rifle was "dead on," he insisted I shoot a 3-shot group. I obliged, and

Dave Brown adjusts the tension on the rollers of the target-turning machine he built for me in 1966. It's still in daily operation.



printed a 2-inch group high and far to the right of the bullseye. When two more shots landed in the same area, he had second thoughts about the quality of his sight-in job. Since I carried a small kit of scope mounting tools in a box I had built for my spotting scope, I adjusted the eye relief, squared the reticle and got the eyepiece focused for him. He admitted he could now see clearly through the scope, and that he didn't have to crane his neck forward to get a full field of view. He was a rather humble man after I finished the preliminary shooting and then put three shots smack in the bullseye. However, I'll give him credit for being man enough to admit that neither he nor his nephew knew much about scope mounting and sighting in a rifle. His offer to pay was refused; I'd had my day in court.

Scope mounting and zeroing rifles took most of my time, and I got further and further from the reloading business. During the early-1960s, our oldest son Darrel was doing most of the reloading. In 1964, my gun shop fell victim to a new highway, and I decided to get out of the gun business entirely. I made plans to build a small reloading room in the basement, and to keep only a single rifle press, powder measure and scale along with a half-dozen sets of dies. Then, I sold an article to *Pennsylvania Game News* magazine.

While I had no serious intention of entering the gunwriting game, I had been contributing to a small outdoor tabloid on a fairly frequent basis. As the bulldozers moved closer to my shop and the road boss told me I had two weeks to get out, I cranked out an article on rifle sights for the tabloid — what I thought would be my final contribution to the gunwriting world. Unfortunately, the editor was having problems of his own, so I mailed to to *Game News.*

Along with a pay voucher came a request for an article on deer rifles. In February 1965, my first "Shooter's Corner" article was published in *Game News.* I've been doing one a month ever since.

I had little time to make a decision about a new shop, but I knew it would be difficult to write gun stuff without a testing shop. The new shop came in 1965, complete with indoor benchrest and a 100-yard range. My late friend Dave Brown built an electric target turning machine for the range. I could bring down a new target by pushing a switch on the inside benchrest. I would be doing most of my shooting at night, so lights were installed on both the 50- and 100-yard ranges. Twenty-three years later, the target-turning machine is still working smoothly, and some 4000 rifles have crossed the inside benchrest. Shortly after building the new range, I zeroed in over 400 rifles during a three-month period prior to big game season.

Remington's 222 and home reloading made a major impact on the shooting fraternity and in all fairness I must say they are responsible for my

writing and shooting career. Each made a major impact on tens of thousands of hunters and shooters of the 1950s. Reloading changed the thinking of a vast number of hunters. No longer were big game rifles stashed in gun cabinets after the hunting season and forgotten until the next fall. Handloading opened the door to inexpensive ammunition. It also allowed the hunter to assemble a batch whenever the spirit moved him. He could now have the best of both worlds — quality ammo at a relatively low price and the luxury of having exactly what he wanted at a moment's notice.

Our daughter Carol inherited her mother's interest in photography, now has her own camera shop.

The 222 not only introduced the hunter to the world of accuracy but also played a major role in upgrading varmint shooting to a recognized sport. The hunter soon realized that hitting a two-gallon oil at 50 yards was not a guarantee a big game rifle was zeroed in. A new term entered the hunter's vocabulary: group potential. To be honest, I can't recall any hunter in my younger days firing more than one or two shots when checking out his rifle's sighting arrangement. As soon as a hole appeared in the can or even close to the bullseye, that was the end of the session. "I know where it's hitting, and that's good enough for me," was a much-used expression that ended the sight-in.

With plenty of ammo to burn, rifle buffs began to test their rifles in a more serious way. It soon became apparent that a rifle had a group potential. As this became better understood, the day of plunking a hole or two somewhere in an anti-freeze can or just splattering a target was over; shrinking group size became the major concern. Crude benchrests began to appear behind barns, on abandoned stripmines, and practically any place that offered 100 yards of open territory with a good backstop. Little by little, the hunter realized home loading had more to offer than just cheap ammo.

The Remington 222 cartridge was the instigator of all this. It may have slipped some from view now, but for a long time it was in a league by itself, and rightfully so.

Gunpowder — Ignition

GUNPOWDER IS THE substance which makes firearms, as we know them, possible. Prior to the invention or development of gunpowder — what is today known as black powder — projectile weapons were limited to such devices as hand-thrown spears, bows and arrows, and catapults of one design or another. All were severely limited in range and accuracy. Gunpowder changed that significantly, enough so it seems safe to say that on numerous occasions it altered the course of history.

Therefore, it seems appropriate to ask, what is gunpowder? The dictionary defines it as an explosive mixture of potassium nitrate (saltpeter), charcoal and sulfur used in gunnery and blasting. That's true; however, it doesn't explain how gunpowder works, and that's the part of vital importance to shooters.

Gunpowder is a combination of solids which, when ignited, burns almost instantaneously, coverting into a large volume of gas. Of its three ingredients, the charcoal and sulfur will burn, but only as fast as air is supplied for combustion. The saltpeter, when heated, gives off oxygen and nitrogen gases. Mixed with the other ingredients, it provides the oxygen needed in an enclosed space, such as the closed (rear) end of a muzzleloading rifle barrel, and all three components burn rapidly. This creates large volumes of carbon dioxide and nitrogen gases, and when confined as here, generates tremendous pressure. The barrel is strong enough to contain this pressure, which means the only movable part of the combination is the projectile positioned just ahead of the powder charge and sealing the bore. Shoved by the violently expanding gas, the projectile gains velocity rapidly until it is expelled from the bore, at which time atmospheric resistance begins to retard its speed and the gunpowder's job is done.

It is not known who invented gunpowder. It probably never will be. In all

likelihood, a number of experimenters came up with similar formulas in different parts of the world at about the same time. Incendiary mixtures collectively called "Greek fire" were known as early as the 5th century BC, primarily for their use in military engagements. Many of these included saltpeter, charcoal and sulfur, though in what proportions is not known. Other ingredients were such things as turpentine, pitch, tars, and similar substances which would contribute to a hot fire. But incendiary mixtures are not necessarily gunpowder, and these were not.

There reportedly is some evidence of gunpowder use in China by 900 AD, but few authorities accept this, except possibly as used in fireworks. Incendiary mixtures, including weak explosives which used the three ingredients of gunpowder, were described in a 12th century manuscript whose title has been translated at *The Book of Fires for Burning the Enemy.* This is generally attributed to Marcus Graecus, but that many have been a pen name. Early parts of the manuscripts are believed based on Arabic formulas for substances which might be called skyrocket powders, while later information added by others over a century or more deals with "near-explosives."

Another name has cropped up for centuries whenever the subject of gunpowder comes up: Bertold Schwarz. Some researchers have claimed he was a German monk who invented not only gunpowder but also guns. However, his birthdate is given as anywhere from 1175 to a century and a quarter later. If the later estimate is true, he was far too late to deserve such credit. The whole question might be pointless, for other researchers claim he never existed at all.

There is one person deeply involved with explosives whose existence nobody doubts — Friar Roger Bacon. This Englishman, whose lifespan covered most of the 13th century, was the first to write about what is now known as genuine gunpowder. He did this in his *Treatise Concerning the Secrets of Art and Nature,* before the middle of the 13th century, following much experimenting with mixtures of saltpeter, charcoal and sulfur. Interestingly, he concealed many of the important pieces of information in word codes, anagrams, etc., some of which were not deciphered until the mid-19th century.

In all likelihood Bacon was familiar with previous writings on Greek fire and developments arising from such mixtures, but there's no doubt his experiments went far beyond those incendiaries. However, Bacon did not use his material in guns, so the term "gunpowder" probably should not be used in connection with the good friar; rather, such use probably first occurred in Moorish Spain where others also were working in this field.

Bacon's development was sometimes called black dust, but generations of muzzleloader shooters have referred to it as black powder. It's black because of its charcoal content. Smokeless powder, which came much later, is normally light colored, almost tan, until coated with graphite to make it feed smoothly through a measure.

The discovery of gunpowder had little impact on mankind until its power and destructive forces were recognized by the military. Shortly after 1300, cannons (shaped like big pots or vases) were used, as were hand cannons, which consisted of an iron or brass tube strapped to a tiller which was nothing more than a wooden pole. They were fired by applying a live coil or hot wire to the powder in a touchhole leading to the main charge.

It was only a matter of time until the military realized that cannons lacked accuracy and were cumbersome to maneuver. While fine for throwing large projectiles over walled cities or battering down forts, they had little physical impact on troops. Several dozen large projectiles really didn't do much damage against an army of soldiers. It's also reasonable to assume that the thunder of cannons soon lost its psychological impact on the enemy. They no longer believed the flaming iron pots were the work of Beelzebub; the orders of the day were probably to concentrate on knocking out these thundering monsters by keeping a steady hail of crossbow arrows raining down on the cannoneers. Big guns had their uses, but what was really needed was a firearm that could be carried and used as an anti-personnel weapon. And so the matchlock or arquebus was born.

The matchlock was the first gun designed to be aimed or pointed while held by the shooter. The name came from its ignition system, essentially a long fuse whose glowing end could be pressed against gunpowder in a hole leading to the main powder charge. It had a distinct advantage: a soldier could now aim at a particular target. This made all men equal . . . at least theoretically. Perhaps Thomas Carlyle was making this point when he said gunpowder "makes all men alike tall."

Early matchlocks used the tiller design, a barrel strapped to a pole. The shooter more or less clamped the wood tiller between his arm and his body to take the recoil and then placed his fire on the touchhole while trying to aim or point the weapon toward the target. It was next to impossible for one man, and not all that easy for two. Accuracy was out of the question, and when the charge was touched off, there was always a danger of the contraption coming apart and killing or seriously injuring the shooter and his helper. Matchlock gunners and helpers lived in constant fear, and not only of the enemy.

It is said that necessity is the mother of invention, and that seems to have been the case here. In time, the touchhole was moved to the side of the barrel

Illustrations from old Bannerman catalog show, from top down, ancient Chinese hand cannon, European matchlock rifled wall gun, wheellock musket, 69-caliber U.S. flintlock musket, and flintlock blunderbuss. (Not to scale.)

and a powder pan added. A new design incorporated the use of a wick or match in a device shaped like the letter S, from which the name "serpentine" derived. The serpentine was attached with a pin that allowed it to pivot so the shooter could pull the match down on the powder charge. At last he could aim to some extent while firing. Later, an innovation resembling a trigger was connected to the serpentine via a linkage or sear. When the trigger was squeezed upward by the shooting hand, it pulled the match down. When released, a spring pulled the match away from the firing pan. Eventually, the spring pressure was reversed and the match was released by the trigger and snapped down on the firing pan. That was a step in the right direction, but the blow of the match hitting the pan could snuff out the fire before it ignited the powder charge. There were enough drawbacks with the snapping matchlock to keep it from being accepted on a wide scale.

While all this was taking place the tiller or pole was replaced with what could actually be called a shoulder-type stock. Barrels were made longer and, in general, the shoulder gun evolved. By the late 1400s, the vast potential of the firearm was recognized; from that point on, it was only a matter of improving it.

The matchlock had many disadvantages. Most obvious was the match itself. It was burning constantly — slowly, but through the extensive inactive period of hunting or military procedures. Countless long lengths just smoldered away, in a sense uselessly, but there was no other way to be ready for a shot when it was presented. If handled carelessly, the match might also set off the powder charge prematurely. Or the smell of its burning, or the glow, could reveal a soldier's position. Anyone who had to put up with such problems on a daily basis must have wished for improvements.

They came, of course. Northern Italy apparently was the birthplace of an ignition device called the wheellock. It derived from a fact that had been known from the days of pre-history — that striking flint or iron pyrites against metal produced sparks. This system had been used to make fires seemingly forever, and in the late 1400s it was refined and adapted to guns.

This system uses a spring-loaded serrated wheel which is wound up about three-fourths of a turn by a spanner wrench and held there, "cocked," until released when the trigger is pressed. The top of the wheel projects through an opening in the bottom of a covered flashpan, where priming powder is placed. A swinging arm that holds the iron pyrites is revolved a quarter-turn to rest on the pan cover. When the trigger is pressed, the pan cover is instantaneously forced open and the pyrite drops into the powder where the spinning serrated wheel makes sparks to ignite it, the flame squirts through the touchhole and ignites the powder in the barrel.

Ferguson flintlock rifle was loaded at breech end of barrel through a hole exposed by unscrewing a plug using trigger guard as a lever.

The wheellock made it possible, for the first time, for the shooter to carry his loaded gun for an indefinite time without the problems associated with a lighted match. Furthermore, its ignition time was extremely fast and dependable, compared to a matchlock's. But the wheellock had its own drawbacks. First it had two dozen or more working parts — sometimes exposed, sometimes covered — each of which had to interrelate properly with all the others. This meant all primary designs had to be precise and all workmanship had to be of very high level. This led to the second drawback: cost. Only a small percentage of the day's gunsmiths could build and maintain good wheellocks, and their services were expensive. Other problems were the pyrites itself, which tended to crumble at inopportune times and was often of varying fire-starting quality; clogging of the wheel's serrations and other parts of the complex mechanism by carbon residue; and the general fragility of such a mechanism.

However, the wheellock proved there were more efficient methods of firing a gun than a lighted wick, and about 1560 someone in the Netherlands developed a system which used spring force on a snapping "cock" to strike a piece of flint against a steel surface (called a frizzen) to produce sparks that ignited the gunpowder in a pan. This in turn ignited the charge behind the projectile. Legend has it that the appearance and movement of the cock so resembled a pecking chicken that it was called a Schnapp-hahn, the appropriately descriptive Flemish term, or snaphaunce.

The snaphaunce used an enclosed snapping mechanism that was much simpler and less expensive than the wheellock's but a lot more costly than the matchlock's, so the latter continued to be used by many, the former by the well to do. The snaphaunce's frizzen was part of a manually rotated arm, while its flashpan cover was a separate piece that was knocked open by a connecting unit when the cock was fired.

In the meantime, far to the south in Spain, another flint-ignition system had appeared. Called the miquelet, it combined the frizzen and the flashpan cover into a single L-shape piece. When the flint stuck the upright frizzen, the whole was knocked back, revolving around a hinge pin to expose the powder in the pan, which was ignited by the sparks coming off the frizzen. The miquelet was an excellent design and was dominant in regions of Spanish influence for several hundred years.

But despite improvements made over the decades, neither the miquelet nor the snaphaunce was without fault. Both had parts which lacked durability, and the miquelet's exposed mainspring was vulnerable to damage. During the second half of the 16th century numerous efforts were made throughout Europe to combine the best features of each type — mainly the snaphaunce's internal mechanism and the miquelet's L-shaped frizzen/pan cover. The English or Jacobean lock of the early 1600s was one such. Development went even further in France, where by about 1625 they also had added such refinements as a vertical rather than a horizontal-pivoting sear. The result has been call a true flintlock.

Probably few gun builders of that time thought the flintlock's ignition system could be improved upon. With only ordinary precautions, the flint and frizzen firearm was dependable even under adverse conditions. However, there is always a tinkering mind looking for a better mousetrap, and the death knell for the flintlock as a major military and hunting firearm was sounded when hard flint was replaced by a percussion cap that fitted over a hollow nipple which led to the powder charge in the bore.

I don't want to imply that the flintlock, or any other system, died instantly when a superior design evolved. All lived on for many years and some were resurrected generations later for various reasons. For example, the flintlock is popular with many hunters in Pennsylvania today. The Pennsylvania Game Commission, at the request of a few dedicated black powder shooters who wanted to deck out in buckskins and use nothing but flintlock rifles, in 1974 set up a special season for fans of this primitive rifle. Today, many thousands of flint and frizzen outfits again belch smoke in Pennsylvania's deer woods.

It's interesting that a Franciscan monk's work with gunpowder was instrumental in starting the gun business, and that close to 600 years later, in the early 1800s, a Scottish minister made a major advance in the firearms field by replacing the hot coal, burning wick and striking flint of earlier centuries with a tiny amount of fulminate. The dictionary definition of fulminates says they are a powder or mixture capable of exploding violently when struck — in other words they are detonating materials — and this

quality led to percussion ignition. Actually, chemically detonating compounds had been known to alchemists since before 1600, but it was over two centuries later before the minister, Alexander Forsyth, recognized that they might be used to ignite gunpowder.

Not only did Forsyth see the possibilities here but he also designed and in 1807 put into production the first percussion gun lock. It was a relatively simple mechanism yet a great leap beyond the flintlock. Ignition was almost foolproof, and it functioned reliably even in bad weather. Forsyth's design replaced the flintlock's frizzen flashpan with an enclosed rotary magazine which held enough fulminate mixture for several dozen shots. This was metered out via a half-turn of the magazine and exploded when a spring-retracted plunger was struck by the falling hammer. The resulting flame passed through the detonating chamber to ignite the powder in the barrel.

Various other percussion systems came along in the next few years, some of them apparently attempts to get around Forsyth's patent, but none was significant until the arrival of the percussion cap itself. This was a tiny metal cap — copper proved best although other metals were tried — into which a fulminate paste was placed. In use, its open end was placed over a nipple which had a tiny orifice leading to the powder charge in the rear of the barrel, and its closed end was hit by the gun's swinging hammer. A Philadelphia artist named Joshua Shaw is often credited with developing the percussion cap, though as always others could also have created something similar. Regardless, the percussion cap became the main transition system between the flintlock, which had served so long, and the metallic cartridge.

After the shoulder weapon was firmly established as a military piece, the quest for accuracy began. The early smoothbore muskets with their loose fitting balls had little semblance of accuracy. Here again, gun builders toyed with the idea of forcing the ball to fly where it was aimed. Doubtless many experiments were tried, but spiral grooves or rifling (that's how the rifle derived its name) in the bore proved the most effective. It's claimed that at first straight grooves were installed to collect powder residue which was a constant source of irritation for the musket shooter. When the straight groves proved successful at this, it was realized that spiraling them in the bore would make them longer, enabling them to collect more residue. These grooves probably helped as they held the ball tighter in the bore, creating more gas pressure and thus giving it more velocity and stabilizing it somewhat in flight.

It had been known for years that feathers set at the correct angle would cause an arrow to spin, making it more stable in flight. Little was known about external ballistics at that time in history, but, as I have explained, there

is always that tinkering genius who is a few decades ahead of his time. A gun builder who was also a dedicated archer could easily see the possibility of applying the spinning arrow theory to the ball in a firearm. Putting spiral grooves in the bore would be a natural approach.

The problem with the loose ball that ricocheted through a musket's bore, making it impossible to accurately guide it, was not solved when the first rifling was installed. The ball still had to be small enough to slide on top of the lands that remained after the grooves were cut in the bore. Even if the ball would slide in, it did not fill the grooves, and chances are it was deformed somewhat as the shooter forced it through the bore. But the tinkering mind came to the rescue again.

Somehow it was learned that using a ball slightly smaller than the bore and enclosing it in a wet or grease-soaked cloth made loading much easier and improved accuracy considerably. It must have been observed that a spiral-grooved barrel was more accurate than earlier designs, even if the principle of rotation was not yet fully understood. Early gunsmiths might not have been aware that the patch not only helped seal the gases behind the ball, giving it more velocity, but also imparted a spin to it because a proper fitting patch grips both the ball and the bore, so to speak. The patch also cuts down on bore fouling, making it much easier to load. With the unpatched ball, the bore had to be cleaned after almost every shot or the shooter couldn't reload. The longevity of a ramrod with such balls was exceedingly short.

Not all the accuracy problems ended with the discovery of the greased patch. Like today's centerfile shooters who tailor a load for their favorite chuck or deer rifle, early riflemen had to find out which ball/patch thickness/powder charge combination gave the best results in his particular rifle. Just as today, this was learned by extensive testing, and hunters of that era were probably just as argumentive over patches, bore diameters and powder charges as they are today over calibers, cartridges and bullet weights.

While hunters of that era were gradually switching from smoothbore muskets to rifled bores, the military was more conservative. They had more at stake. Faster-loading rifles won battles, and smoothbores were quicker to load than rifled barrels. To reload the muzzleloading outfit usually meant standing up for leverage and speed. During that time a soldier was exposed to enemy fire. It was difficult to reload and still watch the surrounding territory for the enemy. A better loading system was next on the agenda. The breechloader was not too far in the future.

The first breechloaders did not use self-contained cartridges like the ones of today. One such system had a fairly large hole drilled through the breech end of the barrel (the hole could be on top, side or bottom) with a screw-in

plug. When the plug was removed, the ball and powder could be placed in the chamber through the hole. It was difficult to screw in the plug when excited and the plug could freeze from powder residue. Also, the plug could be lost. In a later design, the plug was attached to the front of the trigger guard. This gave the shooter a lever for unscrewing it. There was no need to remove the plug entirely to reload; just unscrew it far enough to insert the ball and powder. When the plug was screwed in, the rifle was ready for firing.

Breechloading held too many advantages to be overlooked. In field tests, the breechloader, crude as it was, was far more efficient than the front end loaders. The firearms world was getting closer and closer to the self-contained brass cartridge.

The advent of the self-contained cartridge changed things. The idea was not new, but no one had built a rifle that operated effectively using this system. A London gunsmith, Durs Egg, made a model that allowed the barrel to be tipped for loading. It enjoyed a small degree of success, and other makes using the same theory saw some military use. The main problem with this system was its failure to form a gas seal when closed. Another gun builder, John Hall, improved this method by tipping up the entire breechblock. It failed for the same reason as the Durs Egg model.

Christian Sharps, who had once been associated with John Hall, designed a breechloader that used the trigger guard as a lever to lower the breechblock for loading. When the lever was shoved forward, the breechlock was depressed, exposing the chamber. A paper tube-type cartridge containing powder and bullet was inserted in the chamber. When the breechblock was closed, the rising block cut off the tail of the paper cartridge, exposing the loose powder to the primer's flame. The primer was not an integral part of the cartridge. The self-contained, self-sealing cartridge was in the making, but not yet on the scene.

Christian Sharp's rifle was indeed a major breakthrough, and thousands of them were used. It was only a matter of time until an internal firing pin was used to detonate the metallic cartridge.

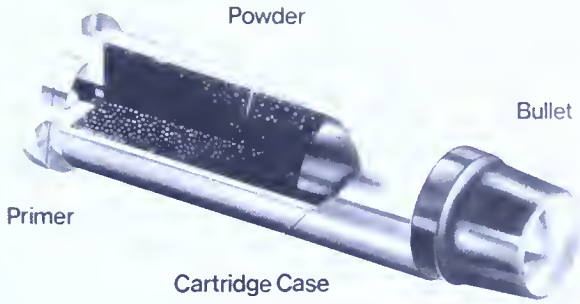
I have mentioned several times the ingenious minds of some experimenters. Many times these men were not the creators of a system, but they made major improvements. One such fellow was a Swiss inventor named Johannes Pauly. Pauly envisioned the self-contained cartridge. He built a gun that incorporated an internal firing pin, cocking lever and break-open breech. The hammer was attached to the side of the rifle. But best of all was the paper cartridge that had a brass head, something like a modern shotshell. Pauly's concept placed the emphasis on the cartridge and that was a major step in the development of the breechloading design.

Cartridge Development

A CARTRIDGE, AS we know it today, consists of four basic parts — a brass case, a primer, a powder charge and a bullet. The case acts as a container for the other parts. Before the advent of this self-contained unit, firearms of course had a projectile which was propelled by the rapidly expanding gas of burning gunpowder which had been ignited by some means. So in a sense they had three of the four essential parts. But they were separate. They had no container to combine everything into a single unit. This caused numerous problems, inconveniences and limitations. Various efforts were made to combine them.

The first cartridge made its appearance in paper or linen, not in brass as many think. Some wise shooter in the mid 1500s came up with the idea of wrapping the powder charge in paper or linen to facilitate carrying and loading. Later the ball was incorporated into the unit. It took but a moment to rip open the paper container and dump the powder down the bore. In later versions the paper was nitrated so it would burn completely and rapidly when used as wadding. There were variations of this, such as the Dreyse "needle gun," which at first was a muzzleloader and around 1837 was introduced as a breechloader. The bullet in the Dreyse design had a primer in its hollow base which was detonated by a long slender firing pin that passed through the powder charge. The firing pin looked much like a needle and that's how the Dreyse got its nickname.

For centuries, the Achilles' heel of the firearm had been the ignition system. A simple dependable method had to be found. From the hot coal and burning wick to pyrite and flint, the quest spanned centuries. It's surprising how long some of these were in use, and what a short period others lasted. For instance, the almost foolproof percussion cap had a very short life — less than 50 years — before being replaced by the metallic cartridge. On the other hand, its predecessor, the flintlock, was in use for 200 years or more.



Four basic parts of a cartridge are the case, primer, powder and bullet.

The percussion cap's short life was probably a result of industrialization. As many of the world's nations turned from hand labor to machines, metals such as brass, iron and copper could be machined or swaged at a rapid pace into sizes and shapes not previously possible or economically feasible. War also puts a heavy demand on — and therefore creates great interest in — the firearms industry. More money is available for research and experiment. The idea of the repeating rifle had been in the minds of many inventors long before the Civil War, but it took a time of crisis to bring it to fruition. Inventions that might have taken decades to see the light of day during peacetime were given the green light during wartime with little regard to financial cost. A comparatively modern example is the atomic bomb. Splitting the atom had been a goal of physicists for decades, but vast sums of money were needed to assemble the brainpower and equipment to do this. It would have taken many years if not for World War II. That was a time of extreme crisis; a weapon of super power was needed, and the atom bomb was produced to usher in the nuclear age.

There had been experiments with metallic-type cartridges but, as earlier, an effective priming system remained elusive. About 1835 a pinfire cartridge was designed by a Frenchman name LeFaucheux. It consisted of a paper case with a brass head. A pin protruding from one side went through the head to a percussion cap on the other side. This system was far from ideal, but it worked with low pressure ammunition, both shotshells and rifle loads.

The metallic cartridge was the answer to the ignition problems of hundreds of years. It evolved in two basic forms, the rimfire and the centerfire. The rimfire was a direct descendant of the French Flobert cartridge, the brainchild of Louis Nicholas Flobert, who patented it in 1847. The Flobert was a metallic case containing a bullet and priming compound

inserted from the inside into the rimmed base. There was no powder charge. The priming compound, a fulminate, supplied the power for this indoor-type gun. This innovation gained tremendous popularity, and Floberts were manufactured around the world by the tens of thousands.

The Flobert design was weak, but it caught the attention of Americans Horace Smith and Daniel Wesson. By adding a few grains of fine black powder, the 22 Short cartridge was created about 1854, and three years later Smith & Wesson introduced it in their First Model revolver. Therefore, it is our oldest metallic cartridge, and still one of our biggest selling. Hard as it is to believe in this era of the magnum, the 22 Short was originally viewed as a self-defense load.

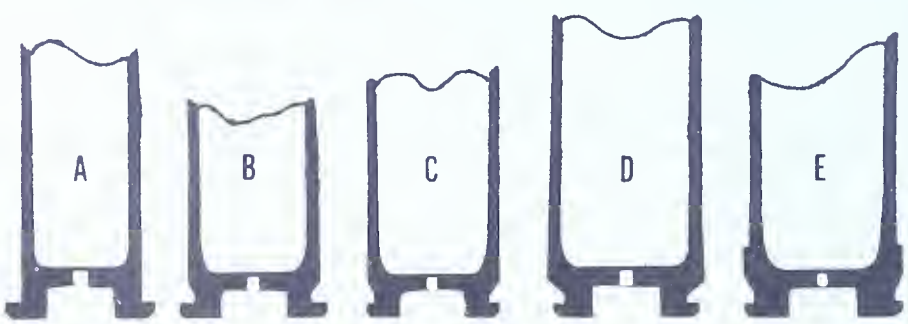
The centerfire cartridge differs from the rimfire in having a separate ignition unit called a primer, which is fitted into a cavity in the case head called the primer pocket. A small hole in the floor of the pocket provides a pathway for the primer's flame into the cases's interior, where it ignites the powder.

Metallic Cartridge

The nomenclature of a formed case includes the terms mouth, neck, shoulder, body, head, extraction groove, rim and, in centerfires, the primer pocket. Cases are almost always made of brass, which is normally 70 parts copper and 30 parts zinc. Other metals and even plastic can be used in certain situations.

The process of forming or drawing a case to its particular specifications is complex. Brass is rolled into strips of the thickness and width needed for the particular cases that will be made from it. The soft brass can be formed, drawn or worked cold. The brass is then punched out into discs of the desired size and each disk is forced through a die to form a cup.

Five types of cartridge cases are: A, rimmed, B, semi-rimmed, C, rimless, D, rebated, and E, belted.



When brass is cold-worked (drawn or compressed) the crystals are pulled out of shape and this hardens the brass. Unless annealed, it will easily crack or break. After it is annealed, brass becomes workable, and by means of a series of draws, trims and annealings, the cartridge case is formed.

Making a cartridge case is far beyond the scope of the home reloader. It's a complex process. For instance, the case must not be of uniform hardness. The head area must be hard enough to resist the sudden surge of pressure when the powder is ignited. If it should fail, the primer pocket can enlarge or the head give way. The rim must be hard enough to withstand the pull of the extractor, but the sidewalls must be able to expand against the chamber walls and seal off gases without splitting. At the same time, the case walls must be elastic enough to spring back after the internal pressure drops for easy extraction.

Today, there are five classifications of case designs: rimmed, rimless, semi-rimmed, rebated, and belted. Rimless is the most common. It works well in any type of magazine since the rim diameter is essentially the same as the maximum diameter of the case body. The extractor groove is cut into the solid head, leaving a rim about .050'' thick. The 270 Winchester is an example of a rimless case. The semi-rimmed case has a rim a little larger in diameter than the case body. The extractor groove is cut just ahead of the rim. The famous 220 Swift has a semi-rimmed case.

Older cartridges such as the 30-30 were rimmed. In this design the rear surface of the case extends outward to a greater diameter than the body. Such cartridges need no extraction groove; the front face of the rim itself provides a surface for the extractor to work on. It also stops forward movement of the cartridge when it is being chambered, by contacting the rear surface of the barrel.

The rebated case came back to life in 1963 in the form of the 284 Winchester. It had been used earlier in a few European cartridges. Here, the case rim is smaller in diameter than the case body. The extraction groove is just in front of the rim. The idea behind the Winchester 284's rebated rim was to allow the use of the standard bolt face of the 30-06 or 308 head but increase body diameter to almost magnum dimensions. This permitted the short action Winchester Model 88 to have almost 30-06 case capacity with the 284 cartridge.

The belted case is used on magnum-type cartridges such as the 300 H&H Magnum. The name derives from a thin narrow raised section just forward of the extractor groove. This larger portion is called the belt. It acts as a rim to stop the forward movement of the case in the chamber, but lets it feed from the magazine like a rimless design.

Whereas black powder is a mechanical mixture of three basic ingredients, smokeless powder is a chemical compound based on nitrocellulose. About 1845 someone learned to make nitrocellulose by the action of nitric acid on cellulose fibers such as cotton. This was the first step in the direction of our modern powders.

According to the Hodgdon's loading manual No. 25, "The method by which modern powders are manufactured can be described as the extrusion process which relies on the formation of a stable nitrocellulose colloid following solvent treatment of raw nitrocellulose. In its solvated state the nitrocelluloses can be pressed and shaped to the desired physical size to provide the correct burning rate in the chamber of the weapon. Other ingredients for the purpose of ensuring chemical stability, burning rate, control, and good flow and electrical conductivity properties are added later." Stringent controls are employed to achieve these criteria.

The quest of the powder manufacturer is good ballistic performance. Powders based on nitrocellulose are described as "single base" because they contain only one active ingredient; they are relatively cool burning. Some powders have nitroglycerine added, so are called "double base." Their burning temperature is somewhat higher. For decades, Hercules was the only U.S. manufacturer to make double base powders for sporting use. The other huge manufacturer, DuPont, concentrated on single base. Then a few years ago it was announced that DuPont's Hi-Skor 700X shotgun powder was double base.

Dozens of powders are now available. In addition to those from Hercules and IMR, a Canadian company which bought DuPont's smokeless powder business in 1986, Winchester-Western, Hodgdon and Accurate Arms also offer top quality powders. One or another can supply most any type a rifle, handgun or shotgun shooter needs.

In many ways all smokeless powders are similar, but each has its own characteristics which differentiate it from the others. This lets handloaders experiment until they find the one which best suits their needs in their individual guns. It's true that many different powders might give essentially the same velocity to a given bullet at the same pressure, but they will not always give the same accuracy out of a given barrel. That might seem contrary to common sense, but it's true. And that's one reason all serious shooters are handloaders. It's the only way they can get the ultimate performance from their own equipment.

Despite all the problems encountered in firing a muzzleloader as discussed earlier, the fact remains that black powder is relatively easy to ignite. Unless the priming powder or charge in the barrel is damp, even a little spark will fire a muzzleloader. That doesn't happen to be the case with

Typical lineup of modern cartridges includes: 243 Win., 244 Rem., 250 Savage, 257 Roberts, 25-06 Rem., 6.5 Rem. Magnum, 270 Win., 7x57 Mauser, 30-06 and 284 Win. Except for the belted 6.5, all of these cases are rimless, the 284 being rebated.

smokeless. Due to its makeup, smokeless powder requires much more flame, or at least a hotter flame.

Cartridge designers worked with many variations of priming devices, so it was inevitable that the self-contained primer as we know it would appear. The percussion cap had been around for years, but installing one in a metallic, self-contained cartridge was difficult. Finally, in the 1860s, two types appeared: the Boxer and the Berdan.

Essentially, a primer is made up of three parts: a cup, the chemical priming compound, and an anvil. Berdan's design uses the first two. A small protrusion centered on the bottom of the primer pocket serves as the anvil. It is flanked by two flash holes. The Boxer, however, consists of all three parts. We tend to think of the Berdan as European, as it is used extensively overseas, and the Boxer as being American because it's the only primer used by ammunition manufacturers in the United States. Actually, an American army officer, Col. Hiram Berdan, came up with the Berdan principle in 1866, and a British army officer, Col. Edward Boxer, gave the world the Boxer primer a year later. It is easy to decap and reload cases that use Boxer primers, very difficult with the Berdan system. As reloading was far more important in the U.S. than in Europe, the reason for the popularity of the Boxer system here is apparent.

Perhaps it wasn't so much the primer cup that had been the major stumbling block, but the priming compound itself. Fulminates of various

From a ballistic standpoint, the 30-30 Winchester, standing, is the least effective of the dozen cartridges shown. Yet in all likelihood it is the most popular deer cartridge ever produced, especially in the handy lever action carbines.

metals such as gold and silver were used as early as the 1600s. It would take another 200 years before the idea of using fulminates as priming compounds would invade the gun industry.

The main ingredient in the primer is the explosive mix. I mentioned that in early primers the cup usually contained fulminate of mercury for its explosive mix. This was unsatisfactory because the mercury attacked the brass and weakened the case, and the salts also attracted moisture which rusted the barrel if it wasn't cleaned shortly after firing. Modern primers contain fuel, an oxidizer and an initiator, and do not affect either the case or the barrel. Many of today's non-mercuric, non-corrosive primers use lead styphnates as the initiator. They have no harmful effects on cases or bores.

The cartridge component that gets the most attention from the hunter/reloader is the bullet. The hunting bullet is normally made up of two materials: the jacket, which is usually made from a copper-zinc alloy, and a lead core. The core is inserted into the jacket and swaged or shaped to form a finished bullet.

Bullet styles, shapes and weights can vary significantly, even in the same caliber. The bullet needs of a rifleman depend a good bit on the game being hunted. There are three general categories here, small game, varmints, and big game. It's not absolutely necessary to use different bullets for each category, but bullets are designed for specific purposes and optimum results will be obtained with the proper choice for a given job. The hunter can select weights and styles such as soft point, spitzer point, hollow point, round nose,

boattail and full-metal jacket. Some hunters prefer unjacketed lead bullets when lower velocities are acceptable.

It takes numerous operations to make a top quality hunting bullet. Manufacturing tolerances are extremely close. The finished product is what the hunter puts his faith in. When it strikes its target, he wants it to perform in a specific way. This could be complete disintegration in the case of a varmint bullet, or carefully controlled expansion and weight retention if a big game slug. The metallic cartridge bullet is more than just a projectile; it's a work of engineering.

At last, the firearm had whipped its worst enemy; a projectile could be guided with a high degree of accuracy and it could do the desired job on impact. All the inherent problems seemed to be solved, Still, the tinkering mind would never cease to strive for improvement, and that is still true today.

It's easy to see that the modern firearm didn't develop during a short span of time. It may perplex some people why it took so long to solve what now seem simple problems, but it's not fair to think that way. The progression of events from the open touchhole to the percussion cap took roughly 600 years. But, it must be remembered that each gun builder used his own ideas or copied from a few different firearms he might have seen. Also, gun builders back then couldn't communicate instantly by phone or computer. They didn't have access to published data, engineering specialists or military experiments; change came mostly by simple trial and error. Each man was his own complete gun factory, and each gun reflected his total talents.

Times have changed. When I attended a Remington gun seminar at Ilion, NY, not long ago, I was flabbergasted at the array of computerized equipment. From stripping down an action on the screen to checking a cutting bit's angle, the computer did it all. Practically any question could be answered instantly by the bank of computers that controlled every phase of Remington's new Flexible Manufacturing System for their 10-gauge magnum action. With such equipment, Bacon and Forsyth would have been able to make all their tests right on the key pad and watch the results form on high resolution screens. Amazing, isn't it? But how will today's computers and modern devices compare with whatever is being used 600 years from now? I don't have to tell you the answer.

For those with deep historical interests, I want to point out that my efforts here are in no way to be construed as a history of firearms. I have barely touched on only the highlights, and not even all of them. True firearm historians may be appalled at what I have omitted, but I'm interested only in giving a short resume of the chain of events that led from Bacon's black dust in the 13th century to the metallic cartridge of the Civil War period.

Projectiles

WHEN MAN LEARNED that a projectile could be mechanically thrown through the air, the art of warfare changed. Clubs, swords, axes and spears didn't disappear, but catapulting large rocks and massive spears that could be deadly at long ranges had a distinct psychological impact on the enemy. For centuries, long range warfare had been conducted by archers, but these fellows still were in range of similarly armed enemies. Rocks and balls of hot iron could be tossed from a catapult, but even these were limited in range. The advent of gunpowder and the firearm not only changed warfare, but history itself. Guiding a projectile from a catapult was almost sheer guesswork, but the firearm made it possible to hit a single small target at a distance. Rocks and balls of iron were replaced with projectiles we now call bullets. Rocks were hard and iron was strong, but lead held the most potential for guided projectiles.

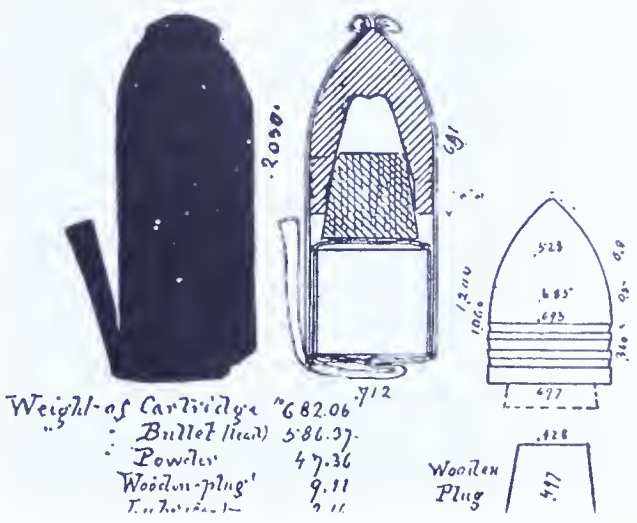
No one knows when lead was first used but it is known that the Romans cast various articles, including military projectiles, from lead. Lead has many advantages for such use. It's readily available, it's inexpensive, and it's easy to work with, though under some conditions it is toxic, a fact that wasn't known until recently. There's no question that lead's greatest virtue is its mass. It has the highest specific gravity of any common metal. Even in this modern day of technological advances, lead still holds the greatest potential as the basic material for bullet making.

Barrel life certainly must have been short with the brass cannons that used stone and iron projectiles. I can imagine the apprehension of a cannoneer when he placed a hot coal on the touchhole of a cannon loaded with iron balls or rocks; he was never certain if the gun would fire or blow apart. The softness of lead, and its low melting point, made it the ideal projectile material. It was easy to cast and would not damage gun barrels.

There is little barrel wear when lead bullets are used. Today's rifle barrels offer an indefinite lifespan with lead bullets. The only real drawback with lead is its velocity limitations. In old low velocity cartridges, that didn't pose a problem, but at high velocity lead tears on the rifling, resulting in an inaccurate projectile and a fouled bore.

Muskets, with their smooth bores, used round balls of lead. No one knows who rifled the first bore or exactly when that happened. One rifle from the 1500s shows a number of spiral grooves. As explained earlier, rifling might have originated as a stopgap solution to powder fouling and then been developed when it was noticed that bores having spiral grooves gave better accuracy than smooth ones. Even if no one knows exactly when, where or by whom this was done, the important thing is that accuracy improved and its relationship to the spiraled grooves was seen.

There were other problems, too. In a musket, the ball was smaller than the bore. In a rifled bore, the ball would have to fit tight enough to "take" the rifling. This meant that a ball had to have a slightly larger diameter than the bore — ideally, it would equal bore diameter plus the depths of two opposing grooves — but this led to more complicated problems. The oversize ball had to be forced into the muzzle and down the bore. Normally, it was started with a short blow and then hammered down on the powder. The ball bit into the rifling but, due to the blows required to push it through the bore, was deformed. This affected accuracy. A smaller ball was easier to load, but permitted gas to blow by, thus decreasing pressure and velocity as well as accuracy. Eventually someone tried wrapping a small ball in a piece of greased leather or cloth called a patch. The wrapper filled the grooves and the ball's smaller diameter permitted easy loading. This was a major improvement in several ways. First, pushing a tight-fitting ball through the bore had taken a deadly toll on wooden



Captain Claude Minié, Frenchman, created the "minny ball" cartridge which was used extensively in our Civil War in the 69-cal. M1842. Illustration from 1927 Bannerman catalog.

ramrods. With the ball and greased patch, there was far less effort. On top of that, the grease on the patch helped remove powder residue in the barrel. It was like killing two birds with one stone. It's reasonable to assume that, long before 1700, the patched ball theory was well understood.

The greased patch certainly gave a new approach to rifle shooting, but it wasn't long until it was learned that proper loading procedures also were important. Just as handloaders today work up special loads for their pet rifles, the shooter of the 1700s had to know which patch/ball/powder charge worked best in this rifle. For instance, the black powder of that day was far from consistent. When a knowledgeable shooter worked up the correct powder charge, he stuck with it until he ran out of powder. In some cases, the ramrod was hollowed out, and even graduated, as a powder charge measure. When a new supply of powder was obtained, it was back to the drawing board to work up a new load.

Ballistic technology, as we know it today, was still far in the future, but there's no question that the rifled bore and greased patch opened the door to early ballistic experimentation. By this time, black powder had reached its fullest potential. Each improvement in shooting performance probably spurred gunsmiths on to higher goals. True accuracy was fast becoming a reality. If I'm permitted a pun, shooting was no longer so much a hit or miss affair.

Still, bullet development was slow. By the early 1800s, a variety of experiments had been carried out with elongated projectiles — bullets rather than balls — and some of their advantages were recognized. It also had been learned that such designs had to be rotated faster than spheres to retain stability. This meant they had to engage the rifling firmly. To do this without a patch meant pushing a smaller-than-groove-diameter bullet the length of the bore and then pounding on it to swell it into the rifling. This was difficult and self-defeating to accuracy. Various methods were tried to get around this. Sir James Whitworth used an unusual approach — a hexagonal rather than cylindrical shaped projectile which was used in a spiraling hexagonal bore. It sounds strange but it worked. In France, two military men, Captains Delvigne and Thouvenin, working about the same time, used different methods to attains some success. Delvigne started with a somewhat concave-base bullet which expanded to fill the grooves when the nose was hammered. Thouvenin installed a steel pin which projected from the face of the breech into the bore. An undersize projectile was shoved in until its base made contact with the pin, then was expanded by hammering to fill the grooves. Both worked, but the problems associated with hammering still remained and obviously had to be eliminated.

Actually, they had been, in England, but almost no one noticed. There, a Captain Norton and gunsmith William Greener, working separately in the 1825-35 period, produced bullets with large hollows in the bases. Greener used a wooden plug to expand the perimeter of the base to fill the grooves, while Norton relied on the gas pressure produced by the burning powder. Either approach was better than anything else so far suggested, but both were largely ignored. A few years later, Captain Claude Minié, a Frenchman, used essentially the same approach to create what became known worldwide as the minié or "minny" ball. Rifles using projectiles of this type did ghastly work during our Civil War.

Bullets or projectiles in the beginning of the black powder era were anything from rocks to chunks of iron. As firearm knowledge grew, more emphasis was placed on the bullet. Today, we have numerous types of bullets. Hunting and target bullets are the most common, but there are special designs for military use, such as tracers and armor piercing. I will stick with the hunting bullet, which can be broken down into two more categories; expanding and non-expanding. For the most part, the hunter is interested in expanding bullets. The non-expanding is generally a large, heavy solid nose bullet used for the largest game animals, or else it's a small diameter bullet used for turkey hunting or some types of shooting where pelt damage is undesirable. Let's go with the expanding type.

The term "expanding" accurately describes today's hunting bullet. That is precisely what it is designed to do immediately after impact. Expansion creates as much killing effect by tissue damage as possible. When I talk about expanding bullets here, I'm not referring to varmint-type bullets designed to literally disintegrate immediately after impact. The front end of the best expanding bullet enlarges uniformly as it proceeds in a straight course through the animal, transferring its kinetic energy to the animal as it goes. Different bullets are designed for different types of game. While it's true that under some conditions even an elephant could be killed with a varmint bullet, it's not true that such a bullet should be chosen for such a job. It will fail far more often than it will succeed.

The first year I had my Model 43 Winchester 22 Hornet, I hunted with it during deer season. On a 100-yard shot at a standing deer, my bullet hit the neck and just nicked the jugular vein. I was unaware that it had even struck the deer, and I fired my second shot at a running target. The deer never flinched. A few minutes later, I caught up to the animal and finished it off. To my surprise, my second shot had hit directly on the hipbone joint. The fragile 45-gr. bullet had disintegrated, causing only a superficial wound. A

large-caliber bullet designed for deer would have probably broken both hips. If my first shot hadn't been fatal, I would not have gotten that deer.

Not all expanding bullets have the same expansion rate. It's not difficult to see why a bullet designed to expand quickly in a deer's ribcage would not be suitable for grizzly. On the other hand, the grizzly-type bullet would tend to whistle right through a deer.

Some years back on the first day of Pennsylvania's antlerless season, I was using a Ruger No. 1 single shot, chambered for the old 7x57 Mauser (7mm Mauser) cartridge. With less than an hour of hunting time left, a doe appeared in heavy brush. I was using a heavy load of 4831 behind a 175-gr. Speer Mag-Tip bullet. When the Ruger cracked, the doe just bounded away. I couldn't believe I had missed an 80-yard shot from a rest. Well, truth is, I had not missed, I found the deer dead over 100 yards from where she was hit. The 175-grain Mag-Tip was the wrong bullet for such shooting. It had simply passed through the ribcage without doing much internal damage. A 145-gr. spitzer would have been more effective. The heavy Mag-Tip wasn't intended for deer-size game; rather it was designed for moose or brown bear and would have been more effective there. The ribcage of a white-tailed deer doesn't offer enough resistance to expand such a slug.

I'm not implying that only one type of bullet works on one species or size of game. That's not true. Today's bullets are to some extent multi-purpose. The point I'm trying to make is that the hunter, especially the handloader, should be selective in his approach to bullets. Thinking of the heavy brush I would be hunting in, I had loaded the 175-gr. Mag-Tip, but I failed to consider other factors that were just as important. Sure, I killed the deer but a fast-expanding bullet would have been a wiser choice. There's no getting around the fact that the bullet should suit the game.

There is always concern that a certain type or weight of bullet won't give top accuracy. This can be a touchy subject, but after firing tens of thousands of bullets of all weights and shapes, I can categorically state that the hunter will seldom miss a big game animal because the bullet wasn't a certain type or weight. Accuracy demands in the woods aren't that critical. That is one reason I feel it's a waste of time to worry and fuss over getting the "right" load for the big game rifle. I'm all for getting good accuracy out of any rifle, but there's a limit to what is needed. Whether the handloader ends up with a 1-inch group or a 2-inch group for a 30-06 or 7mm Magnum doesn't matter in the woods. This may come as a shocker, but I normally use factory ammo for big game hunting. It's plenty accurate and highly dependable.

For a long time, the accuracy emphasis was placed on benchrest-type bullets, normally in 224 caliber. Not an awful lot of attention was given the

Rifle bullets come in many diameters, weights, shapes and designs. Only a few are shown. Some are better than others for specific purposes, so it pays the shooter to look into the subject. The choice can affect results.

general hunting bullet. Most 257, 6.5, 270, 284 and 308 hunting bullets fell into the run-of-mill category — good but not great. The benchrester had to go with custom bullet makers to get an almost perfectly balanced bullet, but the hunter had to depend on what was cranked out by the factory. Over the years, handloading and group shooting on the hunter level stimulated more interest in the balanced bullet. Today's hunting bullet may not have benchrest accuracy, but it can speak very well for itself in the accuracy realm. In fact, big game rifles wouldn't routinely print 1½-inch groups at a 100 yards if today's hunting bullet hadn't been significantly improved over that of a few decades ago.

I have already mentioned that over the centuries projectiles were made from a wide variety of materials, but it was evident that lead had a distinct advantage over all the rest. It's inexpensive and has been known since the 8th century BC. Pure lead was used until after the Civil War, but when smokeless powder began replacing the black stuff and velocities began to climb, it was soon apparent that lead had its shortcomings. Incorporating small percentages of tin and antimony makes lead harder, but even the hardened lead bullet was not suitable for the velocities smokeless powder made possible. Encasing a lead core in a jacket of harder metal such as copper produced the basic modern bullet.

The bullet jacket is usually a deep-drawn cup made from gilding metal, an alloy of approximately 90 percent copper, 5 percent zinc and 5 percent tin. Its purpose is to protect the lead from hot powder gases and barrel friction and to help control the bullet's acton when it strikes game.

Back in the '40s, some 224-caliber wildcatters made bullet jackets from fired 22 rimfire cases when bullets were unavailable due to the war. While the homemade jacket wasn't on par with the factory jacket, it was a reasonable substitute.

In recent years, interest in this subject has revived. Without getting involved in too many details, a fired 22 case is washed thoroughly, heated to

around 550 degrees to aid in point forming, lubed on the outside, placed over a ram punch and shoved into a special die. This irons out the rim of the case. I use a jacket maker kit from Corbin Manufacturing and Supply, Inc., in a conventional reloading press to do this.

Making 224 or 6mm jackets out of 22 cases is certainly an inexpensive way of getting bullet jackets, but the rimfire case happens to be thinner and not as uniform as top quality commercial jackets. I ironed out thousands of fired rimfire cases and used them to swage 52-gr. bullets. I shot some very decent 5-shot groups with them at 100 yards, but I also had a fair share of unexplainable flyers.

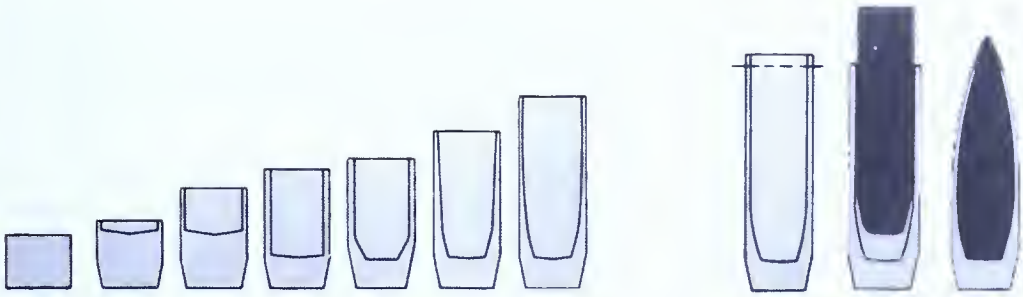
It should be apparent to even the brand new hunter that there is more to a bullet than just its caliber and weight. Unfortunately, many hunters use weight as the sole criterion for choosing a big game bullet. Bullets are designed for specific uses. It's imperative to be selective in choosing one for big game.

We don't hear much about the non-expanding or "solid" bullet, yet it plays a major role in certain types of hunting. The non-expanding bullet has little value to the American big game hunter. It normally has a full metal jacket covering the entire hardened lead core except the base. Some oldsters refer to this design as a "full patch" bullet, and I have heard it called "full-mantle," too. The name is of little consequence. It's designed so it will not expand when it hits game.

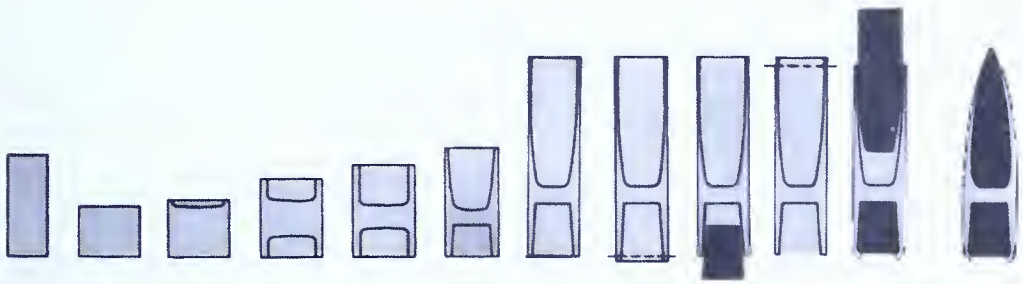
The military has used full patch bullets for many decades. This design is considered more humane than an expanding bullet as it doesn't usually create a large wound channel. African hunters use it on thick-skinned game animals to get the penetration needed on huge species, such as elephants and buffalo. The non-expanding bullet is not designed for deer hunting — and is generally illegal for this — but it does work reasonably well on turkey with low velocity loads. I have known hunters to use the same load for fox hunting that they used during turkey season.

The expanding bullet uses a different approach. It is meant to expand uniformly. When it hits the target, the jacket peels back, allowing the lead nose to enlarge. A good percentage of the nose is often chewed away as the bullet moves through the target. Torn-off particles of both the lead core and copper jacket are sometimes large enough to act as secondary missiles, creating a greater wound volume.

The expanding bullet is primarily intended for thin-skinned game. Its basic purpose is to expand uniformly while penetrating adequately. From a bullet designer's viewpoint, creating such a bullet is no easy task. The rate of expansion hinges a good bit on impact velocity and the muscle and skeletal



Steps in the fabrication of a Nosler solid base bullet, above, and Partition bullet, below. After shearing gilding rod to weight, it is annealed, extruded into a cup by precision tooling, the core is inserted, and a finishing press forms the final shape. In the Partition bullet, a very sophisticated design, a core is inserted from each end.



makeup of the animal. A bullet designed to perform properly on a 1200-pound Alaskan brown bear would hardly give the same rate of expansion on a 200-pound black bear. The physical makeup of these animals, though both are bears, is far from identical.

It's essential to have the rear portion of a big game bullet remain intact for penetration purposes. Bullet makers approach this problem in a variety of ways. Some use an integral ridge to "lock" the rear portion of the jacket to the core. Others use two-piece cores, the rear one of harder lead than the front one. Many impress a deep cannelure or two around the bullet for crimping purposes and also to help hold the rear portion of lead in the jacket. Nosler makes their famous Partition bullet which uses an H-design jacket featuring an integral divider in the jacket and a core inserted from each end. There were many more designs, some of them very complex.

There are a number of ways to make a bullet expand. Exposing the soft lead core at the tip is common and dates back to the origin of expanding bullets. Thinning the jacket at the front or cutting it longitudinally definitely weakens the nose of the bullet. Of course, most of us are familiar with the

hollow point bullet. Even during the money-starved Depression era of the '30s, the majority of rimfire chuck hunters in my area were willing to pay more for the advantages offered by the expanding qualities of the hollow point bullet.

Today's hunter has an overpowering mass of ballistic data available in reloading manual and articles. There are computerized charts and figures for every application in shooting, yet some of this is misleading. Take energy figures for a 150-grain 308 bullet, for example. There are many makes and styles of this popular bullet, but the kinetic energy figure will be the same for all at a given muzzle velocity. I have one set of figures that shows both the 150-gr. spire point and 150-gr. full metal patch bullets produce 2802 foot pounds of muzzle energy at 2900 fps. Yet, it's unlikely these two bullets would release the same energy in a deer or bear, or create similar wound channels. The full patch bullet would probably pass completed through the animal, making only a narrow hole, and wasting much of its energy in the far hillside, while the expanding design would disrupt violently within the animal, creating a large and deadly wound.

Many hunters have definite ideas about what they want in a bullet, and what bullet styles they prefer. During one hectic week-before-buck season, I cranked out a box of spitzer point reloads, even though the customer had emphatically ordered round nose "brush-busting" bullets. Why did I use spitzers? That's all I had left in his caliber and, when he arrived, it looked like I would end up with 20 reloaded 30-06 cartridges. He was really upset. Where he hunted, he emphasized, only a round nosed bullet would break through the brush and, on top of that, a spitzer point would zip right through a deer without expanding. Unfortunately, some hunters still believe that, but it's not true. Speer's Reloading Manual No. 11 says, "Contrary to popular belief, soft point (spitzer) bullets will normally expand as well as round nose bullets. The diameter at the junction of the jacket and lead point has more effect on expansion than does the pointed shape."

It's true that any properly placed conventional big game bullet will kill any deer or black bear, but even on these medium-size animals, some thought should be given to the correct bullet. Consider a bullet such as Remington's Core-Lokt, which incorporates a thicker jacket just behind the tip and has short longitudinal cuts in the front edge of the jacket to help control expansion. A lot of research went into this bullet. I've shot a number of deer with Core-Lokts, and expansion has always been satisfactory.

A jacketed bullet is more than just a chunk of lead wrapped in a copper casing. I mentioned getting puzzling flyers with bullets using jackets made from fired 22 rimfire cases. While I can't put my finger on the exact cause in

each example, it's more than likely the flyer was caused by a jacket that wasn't uniform in thickness throughout.

While a bullet is moving through the bore, it revolves around its center of form. It has no alternative but to follow the grooves that spiral through the bore, and this in turn imparts a spin to the bullet. After the bullet leaves the bore, it spins around its center of gravity. Hence, if a jacket is thinner on one side than the other, there will be more lead on that side; that moves the center of gravity off dead center in the direction of the heavier side. The result is somewhat similar to a clothes dryer that has too many clothes piled against one side. It will not spin evenly. When an unbalanced bullet exits the bore, it too will wobble a bit and not follow a consistent course. The jacket is an important element in accuracy.

A bullet has a technical side. Its energy output and flight are governed by such things as sectional density and ballistic coefficient. These two powerful-sounding terms are blamed for many field shooting problems, but it's a rare case when either is the direct cause of a miss. Maybe a little light on these two elements of a bullet's makeup will give a clearer picture of what they really do.

Sectional density gets worked around in gun articles the same way a promise is in a political speech. Once uttered, it's forgotten. But truth is, sectional density can be accurately determined and verified. In plain language, sectional density is the bullet's weight in pounds divided by the square of its diameter in inches, thus the formula for calculating it is $SD = W/D^2$. All else being identical, the higher the SD reading, the better the penetration. As an example, consider a 105-gr. 6mm bullet. To convert its weight to pounds, divide by 7000 (the number of grains in a pound). This gives 0.015. Then divide this by .243 (its diameter in inches) squared, or 0.059. Its SD is thus found to be .254, if my arithmetic is correct. Sectional density is determined by the bullet's weight and diameter; it does not change with shape. In other words, all 105-gr. 6 mm bullets have the same SD no matter what the shape or style.

Sectional density should not be the only reason, or even the primary reason, for choosing a bullet, though. It's easy to get two bullets of nearly identical SD, yet that does not mean they will have identical power or efficiency. For example, the SD of a 100-gr. 243 bullet is .242, while that of a 165-gr. 308 is .248. With a muzzle velocity of 2960 fps, the 243 has a kinetic energy of 1945 fp, while the 308 at a somewhat slower velocity of 2700 fps has far greater energy — 2670 fp. For most big game shooting the 308 would obviously be a better choice, although the sectional density of these two bullets is almost the same.

But shape is important when a bullet is moving through the atmosphere. A more streamlined bullet slips through the air easier than a blunt-shaped one, thus does not lose velocity as fast, and therefore retains more kinetic energy at long range. That's where the term ballistic coefficient comes in. This is actually a mathematical expression of a bullet's ability to overcome atmospheric resistance. It is closely related to sectional density, and in fact begins with the same basic formula, but adds one more factor to account for a bullet's shape or form. This is usually referred to as the "i factor," so the formula for determining ballistic coefficient is $BC = W/iD^2$. The higher the BC, the better a bullet will penetrate the atmosphere and the flatter it will shoot, assuming a given muzzle velocity.

The difficulty here is trying to determine a bullet's i factor. Most bullet makers and ammunition manufacturers determine it by chronographing a given load's velocity at two ranges and working backwards, as they then know the velocity loss over a given distance. It's unlikely an individual would have the equipment to do this, but in 1936 DuPont ballisticians Wallace Coxe and Edgar Beugless created a chart on which a bullet's profile could be directly checked against a series of point shapes in all common calibers. When the one it matched was found, a listed numerical value could be assigned as the i factor. The BC of the bullet in question could then be calculated. Possible error in this system ran about 10% according to recent research. Nevertheless, a half-century ago the Coxe-Beugless charts were a significant advance in this area.

Nowadays, most custom bullet makers list the ballistic coefficients of their products. Their information might not be 100 percent accurate, but it's far superior to the results most of us could get by the methods available to us — and it's a lot simpler to obtain.

As a quick example of the effect of bullet shape on BC, consider two 6mm 105-gr. bullets, the first with a round-nose, the second with a sharp spitzer point. Though both have the same sectional density — .254 — the BC of the round nose is .256 while that of the spitzer is .395. The latter will have much higher remaining velocity and energy at all ranges. Unlike the SD of a bullet which doesn't change with each shape, the BC does, as clearly shown by this example.

Kinetic energy is another largely misunderstood factor in cartridge selection. Many hunters feel any magnum cartridge "drops them dead in their tracks." Ballistic tables do indicate that, as a class, magnums are more powerful (thus better killers) than standard loads of the same caliber. But if you study those tables you'll see that in almost all cases magnums use the same bullet diameters and weights as standard loads. (For example, the 180-

gr. bullet is the same in both the 300 Savage and 300 Weatherby Magnum.) The only significant difference is the higher velocity of the magnum. Because kinetic energy figures such as those given in ballistic tables are derived from the formula $KE = \frac{1}{2} MV^2$ (where KE is kinetic energy, M is mass and V is velocity), any boost in velocity gives a notable increase in energy because this figure is squared.

However, many experienced shooters deny that kinetic energy figures accurately reflect killing power, or that killing power is the same as stopping power. A spoonful of arsenic will certainly kill anyone, but it may take a long time to do it. Its killing power might be 100 percent, but there would be no stopping power. On the other hand, a brick wall could be totally effective for stopping, but would have no killing power unless it fell on you.

As a bullet decelerates, its path drops quickly and it loses a lot of energy. Catalog energy figures can be confusing because many hunters' ideas of load performance are based on muzzle energy. The hunter should be interested in the amount of energy produced at the average range where he is shooting his game. Applied energy is what kills, and it takes a good bit of it on game the size of deer and bear. For a clean kill, the bullet must reach and seriously damage or destroy a vital area regardless of its point of entry. In big game, it's usually necessary for a bullet to retain some semblance of its original form as it travels through the muscles and heavy bone structure of the larger animals.

The transfer of energy is accompanied by, and partly a result of, the increase in diameter which we call expansion. It's impossible to predict exactly how much a given bullet will expand. There are just too many variables. For a rule of thumb, we can say a properly constructed bullet, used at its intended velocity, will expand roughly two to two and a half times its original diameter.

The right bullet will always be a matter of controversy. Such arguments will continue until the atomic rifle replaces the powder version. One thing is certain: if a hunter expects to make a quick clean kill, his bullet must be placed in a vital area. Proper bullet placement is more important than the weight or style of the bullet. That's a point worth remembering.

The Military's Contribution

I DON'T INTEND to dwell on this particular subject. I'm more interested in discussing hunting guns and ammo than giving a rundown on what the military has accomplished in this country or its contribution to the hunter. Still, it's only fair to mention some of what the military minds of the world have contributed to the modern centerfire cartridge. Millions of big game hunters have used with good success both ex-military cartridges and rifles.

Beyond a shadow of a doubt the nod must go to research and development. Military ammo is the end result of millions of dollars being spent in this field. The military leaves no stone unturned to come up with the best. Many military cartridges are well suited for hunting when used with expanding type bullets. As an early example, the old 7x57mm (7mm Mauser) which dates back to 1892 is still a top cartridge for the smaller big game species. We can step farther back in time to the era of the 45-70. This black powder cartridge (45 caliber, 70 grains black powder) became the choice of our military in 1873 in the trapdoor Springfield. It was our official service cartridge for two decades until replaced by the 30-40 Krag in 1892. This single shot 45-70 didn't die immediately after the introduction of the Krag. It was used extensively during the Spanish-American War in 1898.

The 45-70's usefulness as a military weapon died with the Spanish American War even though it hung on in National Guard outfits for decades. Still, a surplus of military 45-70s was available to the public, and the cartridge caught on as a reliable big game load at woods ranges. Some arms manufacturers even made lever and bolt action rifles for the old cartridge. Winchester kept their Model 1886 rifle in production until the mid-1930s. After years of disregard, Ruger gave the 45-70 new life when it introduced it in 1973 in their Model 3 single shot, and Marlin came out with their fine lever

action Model 1895. In recent years, quite a few guncranks have become intrigued with large calibers and many built 45-70s on Siamese Mauser bolt actions. The strength of this action permits using heavy handloads, and though bullet weight and diameter don't lend themselves to flat trajectory loads for long range shooting, they can deliver great amounts of power that will handle any North American game in the woods. Current loading manuals indicate that in the Ruger No. 1 and No. 3, as well as rifles built on good bolt actions, the 45-70 case can give a 300-gr. bullet 2400 fps, the 350-gr. 2200, the 400-gr. 2000, and the 500-gr. 1800. This is significantly higher velocity than the M1895 Marlin or M86 Winchester lever guns can begin to approach, and of course the old trapdoor Springfield should never be shot with any load that exceeds factory levels. Maybe not even with such loads, as it's an awfully old gun. But in the Ruger single shot or a good bolt action, the 45-70 can be very efficient.

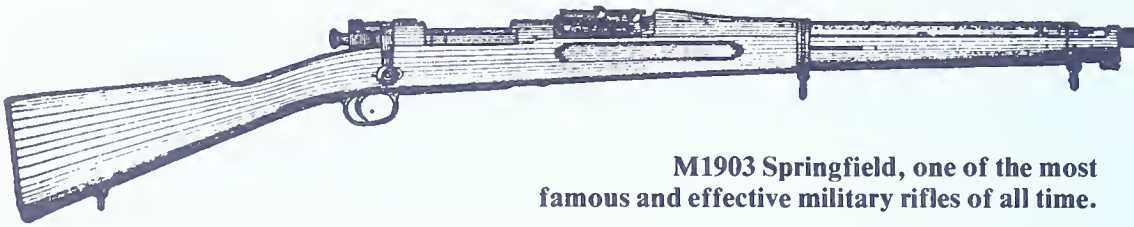
I can't pass up an opportunity to tell about a deer hunt that involved the 45-70. In the late 1950s, an acquaintance who knew nothing about ballistics borrowed a 45-70 for deer hunting in very open country. The sad part is, he selected the old cartridge over a 270 Winchester. He claimed the big bullet was a better choice. My advice about the inadequacy of the 45-70 for long range shooting fell on deaf ears; he was convinced its 405-gr. slug would do the trick.

The object of the hunt was a large buck known as "Ol' Hayrake" because of its rack size and point count. Every hunter who saw it increased the number of points until it finally reached 18 or 20. My friend was convinced he knew where the buck was, and as it turned out he was right.

Late in the afternoon of the last day, Hayrake came out of a woods almost 350 yards away. The buck was intent on digging through the snow in search of something edible. It was a perfect side shot — just what my friend had dreamed of. He was positive the big slug had unlimited range, so he used a dead-on sight picture. When the old trapdoor rifle was rested against a tree with the iron sights planted more or less on the ribcage, it was a foregone conclusion in my friend's mind that Ol' Hayrake's massive rack would soon be above his mantle.

At the first shot the buck raised his head and looked in the shooter's direction. He ignored the second — just lowered his head to eat whatever he had uncovered. The third shot was a repetition of the others, and the buck kept right on pawing. The fourth made him nervous and he ambled back to the edge of the woods. A final desperation shot was fired, but the buck melted into the shadows. The rack would soon be shed and lost forever.

A search did not produce any evidence of where the bullets had hit. The



M1903 Springfield, one of the most famous and effective military rifles of all time.

final blow came when a more knowledgeable shooter found bullet grooves in the field far short of the big deer. They told the sad story of the 45-70's long range potential — or lack of it. It was a bitter defeat that the 270 Winchester might have prevented, but such is life.

The successor to the 45-70, the 30-40, was a favorite of Pennsylvania deer hunters during the Great Depression. My brother-in-law, C.J. Clawson, told me he bought new unaltered 30-40 Krags for $2 each in lots of a hundred in the early days of the Depression. The going price for a Krag in those days was between $8 to $10. That compared to $45 for a Winchester Model 54 in 1932 or $80 for a Model 99-K takedown Savage. The Krag's low price was certainly an inducement. Another factor that kept the Krag alive as a hunting outfit was its effectiveness. With the 150-gr. bullet, the Krag can produce muzzle velocities in excess of 2600 fps and the 180-gr. spitzer will bump the 2400 fps figure. Obviously, such loads will handle the vast majority of American hunting situations.

I'm going to end the military aspect of this by just touching on the cartridge which is known to hunters around the world as the 30-06. The term derives from its caliber and year of birth. When it appeared as a military round in 1906, it was designated the "Ball Cartridge, Caliber 30, Model of 1906." It wasn't long before American hunters were using it for all species of big game, and it became, in all likelihood, the most popular centerfire hunting cartridge of all time. At least it would be difficult to name a more popular one. The reasons are simple. It has adequate power for all species of North American game except possibly Alaskan brown bears in thick cover (and it has served well even there); its accuracy is fine at all ranges; recoil is average; and a wide range of bullet weights is available in factory loads, to easily handle anything from whitetails to moose. Nowadays, Remington even has a 55-gr. Accelerator load for varmints. And of course the combinations available to handloaders are almost limitless. In the end, it's hard to say too much about the 30-06 as a hunter's choice. But it doesn't hurt to remember that its original function was as a military cartridge — in the legendary Springfield rifle of World War I and the equally impressive M1 Garand of World War II. And it did the job there too.

Overall, the military's influence on the fields of firearms and ammunition has to be considered significant and impressive.

Rifles — A Quick Look

I AM NOT going to backtrack through firearms history to the time the shoulder weapon made its appearance. Nor will I try to say specifically when the shoulder weapon first might have been used for hunting. But I do have to start sometime, and I can't think of a more reasonable time than when the shoulder arm first came to America. At least this won't take us back to the Dark Ages.

Spanish explorers brought the cumbersome harquebus whose belching and roaring made even friendly Indians tremble. The Spaniards thought of their guns more in terms of military use than for obtaining food. When Europeans began to settle farther up the coast of the mainland, the lack of a reliable hunting gun brought them close to annihilation and starvation.

The German Jaeger was another ungainly large-caliber outfit. It was a beast to load and the weight of its projectiles limited the number that could be carried. This was a problem under frontier conditions. If the colonists were to clear and cultivate the land, a better firearm for protection and hunting had to be developed. The frontiersman of the 1700s needed a lightweight, small caliber, high velocity rifle that was accurate to 200 yards or so with simple open sights. It didn't need the power of the Jaeger's heavy projectiles because there was no large dangerous game in this region. The accuracy requirement meant it had to be a rifle, not a smoothbore, and it had to be quick and easy to load. The answer was the Kentucky rifle — more precisely called the Pennsylvania Long Rifle because it was created in the eastern part of this state.

The Long Rifle was the near-perfect answer to the needs of the time and the place. It satisfied the hunter's requirements and, toward the end of the century, was helpful in winning the Revolutionary War. There, it was the specialist's weapon, not that of the mass of troops. Nevertheless, there were

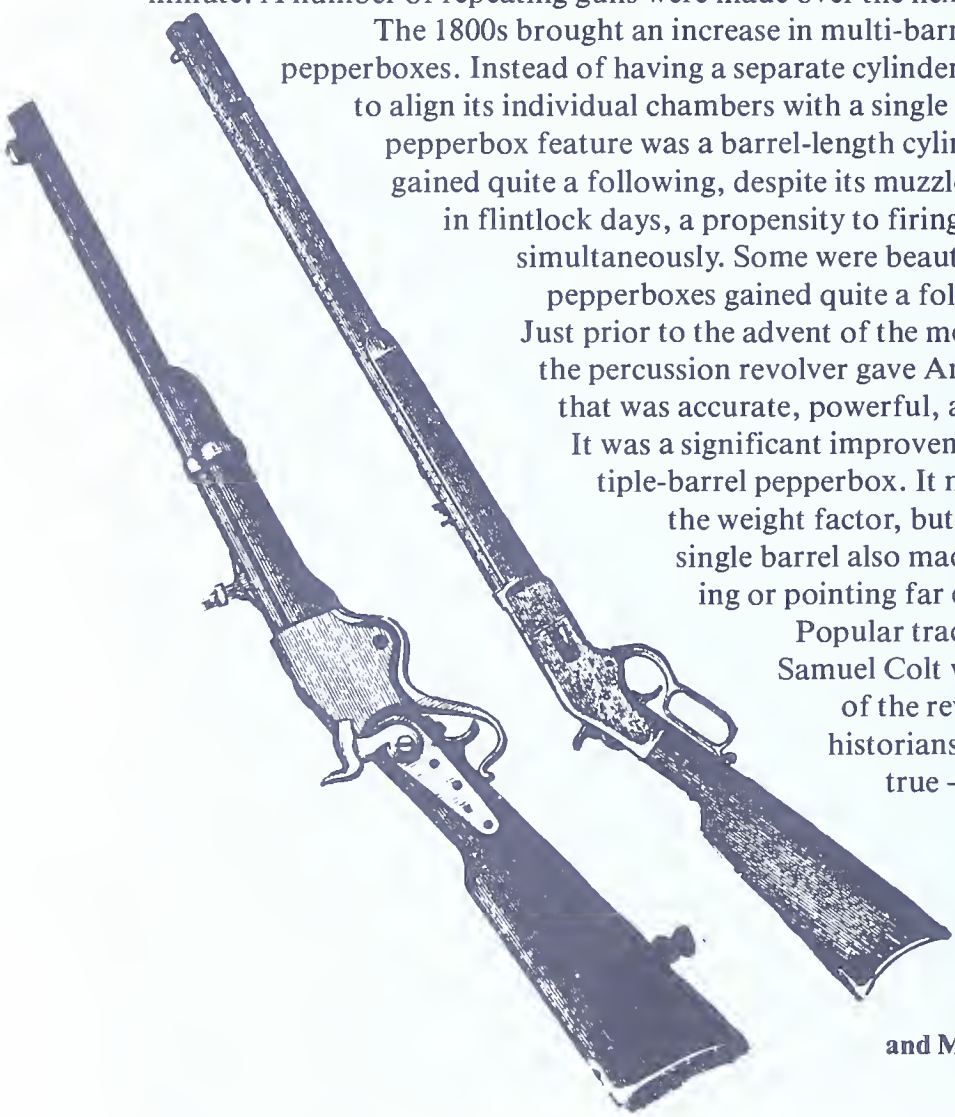
times such riflemen made the difference between victory and defeat. So the Pennsylvania Long Rifle holds a place of honor in our history.

But despite all the advances that had been made with the flint and frizzen ignition system, it became obsolete when the percussion system, and then rimfire and centerfire cartridges, were developed. The centerfire cartridge also brought a new surge in the development of repeating firearms. Repeaters had existed for many years in the form of revolving barrels or a rotating cylinder such as in the Puckle gun. That was the brainchild of James Puckle, around 1718. It featured a rotating cylinder that was turned by a crank. It was not a success even though it was possible to fire 7-8 shots per minute. A number of repeating guns were made over the next century.

The 1800s brought an increase in multi-barreled guns called pepperboxes. Instead of having a separate cylinder which revolved to align its individual chambers with a single barrel, the main pepperbox feature was a barrel-length cylinder. The design gained quite a following, despite its muzzle heaviness and, in flintlock days, a propensity to firing several charges simultaneously. Some were beautifully made and pepperboxes gained quite a following.

Just prior to the advent of the metallic cartridge, the percussion revolver gave America a firearm that was accurate, powerful, and dependable. It was a significant improvement on the multiple-barrel pepperbox. It not only reduced the weight factor, but looking down a single barrel also made accurate aiming or pointing far easier.

Popular tradition has it that Samuel Colt was the inventor of the revolver, but arms historians know that isn't true — not by several



Spencer repeating carbine, far left, and M1866 Winchester.

hundred years. However, Colt did refine the revolving-cylinder system into an extremely practical design, he produced parts so accurate and consistent that they could be interchanged, and he used what would later be called an assembly line process to speed up production. The net result of all this was a well-designed and efficient product at a price which didn't limit sales to the well-to-do.

In 1857, Smith & Wesson introduced their First Model revolver for the 22 Short. The self-contained cartridge was finally a reality. The days of uncertain ignition were in the past. However, the revolver, with all it had to offer, was not the total answer. It was difficult for many to shoot accurately, and it was not suitable as a genuine hunting outfit. Its primary uses seemed to be for self-defense and as a secondary military weapon. For most shooting needs, both military and sporting, the repeating rifle held more answers.

Once again, getting through all the versions of the repeating rifle will be left to the historians, but it's worth mentioning that in 1860 Christopher M. Spencer in Connecticut patented a workable 7-shot repeating rifle. It held its shells in a tube magazine in the buttstock. The trigger guard served as a lever. Shoving it down and bringing it back ejected the fired empty and fed a fresh round into the chamber. This did not cock the rifle, however, and that was a drawback.

Shortly after the appearance of the Spencer came the lever action Henry rifle. It held 15 cartridges in a tubular magazine under the barrel and, with the one in the chamber, the Henry became known as a "sixteen-shooter." Misfires were a constant menace with rimfire cartridges in those days, therefore B. Tyler Henry designed his rifle so the firing pin simultaneously struck two places on the rim of the 44-caliber metallic cartridge. This was almost a sure guarantee of ignition. Henry was honored by having his initial "H" stamped on the head of each cartridge.

The Spencer rifle may not have been a better military outfit than the Henry, which evolved into the Winchester, but it had the backing of President Lincoln. In fact, Lincoln personally tested the Spencer rifle. The military purchased over 100,000 Spencers and total sales to states and municipalities probably doubled that figure. It figured prominently in the battles of Antietam, Gettysburg and elsewhere. However, the Spencer rifle died shortly after the close of the Civil War, and Winchester gained almost a monopoly on the rifle business in this country.

The lever action had more than made a name for itself during the Civil War. The move westward brought more fame and glory to Winchester's Models 1866 and 1873. But lever action outfits are complicated and limited in the size of cartridge they can handle. More powerful loads were needed for

animals such as buffalo and required larger and stronger actions than could be incorporated into the levers of that day. Even as the Henrys and Spencers were being called unbeatable by some, others were at work on ideas for improved and stronger actions. The bolt action rifle was soon to walk on the world's stage.

The idea of a bolt action had been experimented with during the Civil War period, but most still stuck with the Henry idea of a tubular magazine under the barrel. About the time Spencer was sold in 1869, thousands of miles away in Oberndorf, Germany, Peter Paul Mauser put the finishing touches on a single shot bolt action design, the Model 71 Mauser. Later he added a cartridge-holding tube in a repeater version, and continuous work over the decades culminated in his masterpiece, the most successful bolt action of all time, the Model 98 Mauser.

The idea of a box-type magazine located directly under the bolt belongs to James P. Lee. This permits the use of sharp-pointed bullets and faster loading systems. His idea was an instant success, and by 1899 the box magazine was used around the world.

Another arms designer, Ferdinand Ritter von Mannlicher of the Steyr Works in Austria, invented a clip-loading, single-column magazine system which allowed rapid reloading of the bolt action magazine with just one motion. Another loading system, the rotary spool magazine, was developed near the turn of the century by the director of the Steyr Works, Otto Schoenauer, and is the most notable feature of the famous Mannlicher-Schoenauer rifle. Interestingly, neither Mannlicher nor Schoenauer had anything to do with the basic design of this rifle.

With the development of clip-loaded box magazines, the bolt action was ahead of the lever action in regard to ease and speed of loading and the use of long-range projectiles. The lever is still with us, of course, and has been improved in various ways over the years, but it was the bolt action's simplicity and strength that cleared the way for the modern centerfire high pressure rifle cartridge. With it, the repeating rifle essentially had been perfected.

How a Rifle Operates

FIREARMS FUNCTION ON a seven-step operational procedure — actually eight steps when we consider that a safety or hammer must be moved to start the procedure. These steps vary with certain types of firearms and, in some cases, two operations may be working at the same time. Yet it's mandatory for each step to occur.

Feeding is the first step. This is putting a fresh round into the chamber of the barrel. The round can come out of a magazine or it can be inserted manually, as in a single shot rifle. The firearm must then be locked. Locking holds the bolt or breechblock secure during the chamber pressure buildup when the cartridge is fired. Most guns cannot be fired until locking takes place. The next step is cocking the firearm prior to firing the shot. Depending upon the firearm, this is done either manually, as with a single action revolver, or it can be done automatically as the bolt is operated. In essence, cocking occurs when a strong spring is compressed and retained in that position. Firing is the act of pulling the trigger. This releases the energy stored in the spring to drive a hammer or firing pin against the primer. The sharp blow detonates the primer, which ignites the powder charge. As the powder burns, gas pressure builds and drives the bullet through and out of the bore.

Unlocking is next. In this step, the locking lugs which hold the bolt solidly in position during the stress of firing are moved out of their restraining recesses when the action is functioned to open the bolt. Opening the bolt leads to the next step, extraction, which is the removal of the fired case from the chamber. The last operation is ejection. A metal unit called the extractor pulls the empty case from the chamber; it is retained in the bolt face until, near the end of the rearward travel of the bolt or breechblock, the case head strikes a protruding piece of metal known as the ejector. The impact knocks

(ejects) the fired case from the gun. Thus, the extractor pulls the case from the chamber and the ejector kicks it out of the gun. I repeat that because many shooters have trouble differentiating between the two parts and their functions, through their nomenclature should make it perfectly clear.

The ejector's position in the action determines the angle the empty case will travel. In the original Winchester Model 94, for instance, the case is flipped straight up. On a slide action rifle, ejection is out of the side. Most bolt action rifles throw the empty up and out on a 40/45-degree angle to avoid hitting the scope. I used to hunt with a very fine 22 rimfire squirrel outfit that tossed the empty up against the scope, and it almost always fell back into the action, causing a problem if I needed a quick second shot. As it wasn't my rifle, I couldn't alter the ejecting system, so I devised a little angled hood to guide the empty away from the action. I spent one entire evening designing this masterpiece and a second evening making and installing it. It showed a lot of promise on the range, but when I needed a quick second shot in the woods the empty case invariably fell back into the action. Such is life.

Another ejector design is the plunger type. A springloaded plunger protrudes from the face of the bolt. When the bolt is closed against the case head, the plunger is shoved back into the bolt. As the case is being pulled out of the chamber, it is under pressure from the plunger. When it clears the action, it flies out.

In my view, the safety is part of the firing system. Most all firearms are equipped with some type of safety mechanism. Safeties can be a simple cross-bolt design that blocks the trigger. Many pump and autoloading shotguns have such safeties. This type prevents the trigger from being moved. In many bolt action rifles, the safety works on the firing pin. When placed on "safe," it normally pulls the firing pin back about 1/8 inch so it is not engaged with the sear. This is necessary so the trigger and sear can move without touching the firing pin block. This is an important safety factor. The sear and firing pin block must not touch when the safety in "on safe." If this should be the case, and the trigger is inadvertantly pulled when the safety is on "safe," the rifle can fire when the safety is put into the "fire" position. When the safety is working as it should, it holds back the firing pin. When flipped into the "fire" position, the firing pin moves forward and contacts the sear. When the trigger is pulled, it disengages the sear from the firing pin, allowing the firing pin to be driven forward under strong spring pressure.

Each rifle obeys all seven steps, but it's just as true that different rifle designs operate in different ways.

The Single Shot

So far as actions go, the single shot is a good place to start. The first types favored a lever operated falling block design. In simple terms, a steel block which supports the rear of the case head moves downward when the lever is actuated. At the same time, the empty cartridge case is extracted and can be removed by hand, or in some types is ejected from the rifle by a spring-loaded unit. Another type was the rolling block made famous by Remington in the late 1860s. It functioned on the simple principle of rotating the breechblock back to expose the chamber.

I happen to be an admirer of single shot rifles. The one-shot philosophy appeals to me. It puts a heavy obligation on the hunter for he has no fast backup shot. It brings out the best in the hunter. The single shot certainly isn't everyone's idea of the perfect chuck or deer rifle, but it adds a certain degree of satisfaction to the hunt.

I once watched a deer for a full two minutes before I fired. I'm sure if I had been carrying a repeating rifle, I would have fired seconds after determining it was a legal buck. It was in range from the instant I saw it, but with only one shot possible, I wasn't in a position to make a mistake. All factors had to be considered. It was a case of making certain all the odds were in my favor before squeezing off the shot. Watching and waiting for the right moment really put a strain on my nervous system. My shot dropped the buck, but I can't recall another hunting situation where I had sweat on my forehead and cold clammy palms.

The Bolt Action

The bolt action is by far the most popular design around the world. The military brought it prominence, although for generations now the world's armies have been abandoning manually operated firearms for automatics and semiautomatics. The philosophy of the military today is firepower. This is quite a contrast from their view back in Civil War days. In 1862, the nation was at war and in dire need of improved firearms. Oliver Winchester, then president of the New Haven Arms Co., felt he had what was needed. But when he attempted to interest the government in his breech loading repeater, General James Ripley, then Chief of Ordnance, voiced strong opposition. He cited a number of reasons, but the one that stands out like a sore thumb was his feeling that soldiers would waste ammunition with repeating firearms. He couldn't see the forest for the trees.

Paul Mauser designed the first practical bolt action around 1872. It would take another two decades before a bolt action that's essentially as we know it today made its debut. That was the Model 1893 Mauser. This action has

often been called the Spanish Mauser because it was adopted by that country. This action has a box magazine under the bolt. Its design put the cartridges in two partly overlapping stacks in the magazine instead of having them in one vertical row. By staggering the cartridges, the magazine could be made shallower, flush with the bottom stock line, without reducing capacity.

The advent of the staggered box internal magazine made the use of sharp pointed bullets feasible. Tubular magazines had to use flat nosed bullets to avoid setting one off in the tube, as recoil could slam the point of a sharp-nosed bullet into the primer of the cartridge ahead, and the result would be not only the loss of the firearm, but perhaps the shooter's hand as well. Although much about the flight of the bullet was unknown when the box magazine was introduced, the use of the spitzer bullet with its higher ballistic coefficient certainly improved long range efficiency.

The bolt action design is fairly simple. To operate, the shooter lifts the bolt handle (as little as 54 degrees with some versions, but 90 degrees on most). This cocks the firing pin and frees the locking lugs from their recesses.

The bolt action offers a tight lockup. The old Krag had a single locking lug, but most designs have two large lugs near the front end of the bolt which turn into recesses inside the top and bottom of the receiver ring, plus a third — so-called safety-lug — toward the rear of the bolt. This third lug does not make contact with anything during normal bolt manipulation; its function is to keep the bolt from blowing to the rear if through some circumstance the front lugs simultaneously failed. The M98 Mauser and M1903 Springfield are examples of the dual front lug design.

In comparatively recent years, some gun designers have used different numbers of locking lugs. The use of three up front instead of two can at least theoretically give more even support to the case during the stress of firing, plus reduce the arc of the bolt lift from 90 to about 60 degrees. Champlin Firearms Co. and Ranger Arms' Texas Magnum rifles are examples of actions with three front lugs. The Weatherby Mark V action has nine front locking lugs, in three rows of three each (the smaller Varmintmaster action has six lugs, three rows of two each).

Other manufacturers have taken a different approach and moved the locking lugs to the rear of the bolt body, just forward of the bolt handle. Examples are the Remington M788 and various Schultz & Larsen rifles such as the Model 54J and its successors. The S&L actions use four lugs spaced evenly around the bolt's circumference, and the root of the bolt handle serves as a safety lug, while the 788 Remington has nine lugs, three rows of three each. Such designs eliminate the need for recesses in the receiver ring, so steel thickness there, and thus strength, is great.

There have been numerous arguments whether multiple small lugs have any advantage over the traditional two large locking lugs. Because the smaller ones are arranged in units of three, they do permit lower bolt lift and possibly smoother manipulation. And since their total bearing surface is larger than that of the two lugs in the M98 Mauser and its derivatives, it can be argued they are stronger. However, it's debatable if this has any significance, as many tens of millions of two-lug actions have proved this design has a great safety margin itself.

One of the problems of multiple-row locking lugs is machining everything accurately enough that all lugs bear solidly against the supporting surfaces of the recesses when the bolt is closed. At least in the early days of such designs, it was sometimes found that some lugs in a unit did not make contact. Perhaps that was to be expected, for serious riflemen have long known that the same situation often exists in two-lug bolts, and shooters interested in top accuracy have long had such units lapped in to maximize their bearing surfaces. A gunsmith can check either two- or multiple-lug systems by applying a thin coating of Prussian blue to the lugs and working the bolt to see where contact is, or is not, made.

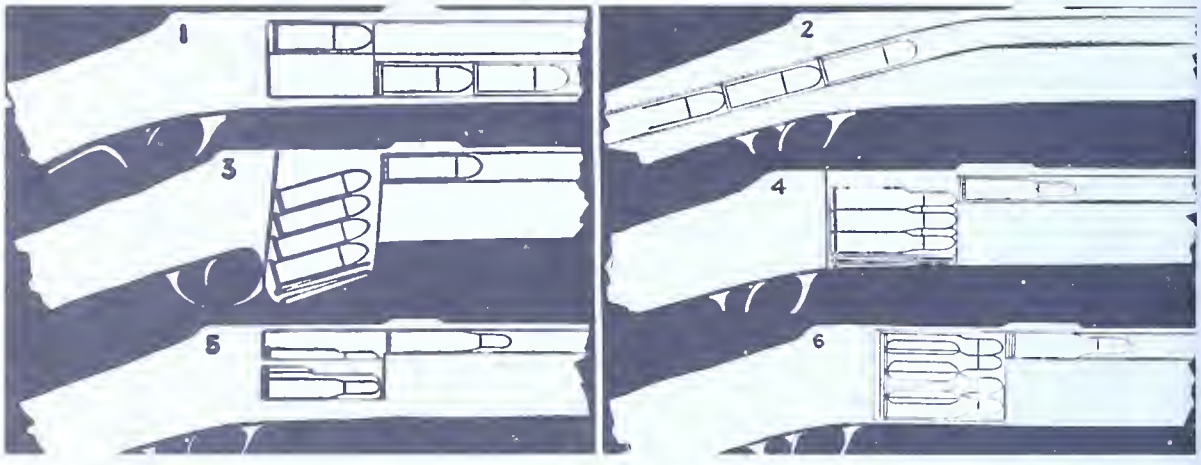
After the cartridge is fired, unlocking a bolt action rifle is a simple matter of lifting the bolt handle. The bolt is moved backwards slightly by a cam, which breaks the case loose in the chamber for easy removal. This is called primary extraction.

Extraction with older bolt actions such as the Model 98 Mauser is carried out by a sort of metal hook that is fastened to a collar on the side of the bolt and fits around part of the front surface of the bolt face. In a more modern design, popularized by the Model 700 Remington, the extractor is a metal ring fitted into the recessed bolt face. As the bolt is pulled backward, just before it reaches its maximum rearward travel and contacts the bolt stop, the left side of the case head hits the ejector, which flips the case out of the gun.

As the bolt reaches its rearward limit of travel, the magazine spring forces another cartridge upward into a ready position. When the bolt is shoved forward, it contacts the live round and shoves it into the chamber. Turning the bolt handle down locks the lugs in the receiver, and the rifle is ready to shoot again. The simplicity of the bolt action's design is one reason it's so efficient. There is little to go wrong, and the power the user exerts is multiplied by camming surfaces on the bolt, rather than being reduced in the final closing movements as with a lever or slide.

The Lever Action

Lever action big game rifles number in the multi-millions. I believe the



The six most successful types of magazines in manually operated repeating rifles are shown in these sketches from the 1927 Bannerman catalog: 1, Henry (Winchester) under-barrel tubular style; 2, Spencer buttstock; 3, James Lee vertical magazine; 4, Mauser vertical in-stock design; 5, Krag-Jorgenson horizontal magazine, and 6, rotating ratchet design such as used in the Mannlicher-Schoenauer and M99 Savage.

Winchester M94 is the most popular. Approximately seven million of this model and its derivatives such as the M64 have been sold, as well as tremendous numbers of the similar-appearing Marlin design. Both the Winchester and Marlin are readily recognizable by the flat-sided action with its external hammer and the tubular magazine which in the carbine version extends to the barrel's full length. Such a magazine precludes the use of spitzer bullets, because when loaded the sharp nose of each bullet would rest against the primer of the cartridge ahead of it; this could lead to firing one or more cartridges in the magazine due to recoil when the cartridge in the chamber is discharged.

The Winchester and Marlin carbines have a neat compact look to them which I've always believed helped their popularity. Other early lever actions such as the Bullard, Kennedy and Burgess, now long gone, had a similar appearance.

The lever action is an American development and dates from the middle of the 19th century. For decades it was the dominant big game rifle type in America and it still has a tremendous following. It's a boon to the hunter who shoots from the left side, of course, but a huge segment of right-handed shooters are avid lever fans too.

As with other rifles, the lever action's mechanism is activated by pulling the trigger. This releases a hammer, either external or internal, which strikes the firing pin and detonates the primer that ignites the powder charge. The lever is shover downward to unlock the action. Unlike the bolt action which

cams the bolt back slightly to free the case from the chamber, the lever action just pulls a locking bolt (sometimes two) down out of contact with the rear of the breechbolt. Unfortunately, guns such as the Winchester 94 and the Marlin 336 do not offer primary extraction, which is one reason they are not suited for some of the more powerful big game cartridges.

The extractor on the bolt face catches the rim of the case head and pulls the empty out of the chamber as the lever is pushed downward. The Winchester 94 and its variations throw the empty upward. In the Marlin, the ejector is a permanent part of the left side of the receiver. When the empty strikes the ejector, it is tossed out of a port on the right side of the action. Here again, two operations are accomplished with one movement by the shooter. As the bolt is moved backward for extraction, the hammer is pushed back into its cocked position.

Feeding starts on the Marlin when the lever has just begun its rearward travel. A cartridge is freed from the spring-loaded tubular magazine and is pushed onto the lifter or carrier. In the Winchester, the carrier is lifted as the lever starts its forward travel and the bolt pushes a fresh round into the chamber when the lever is pulled back. Both rifles use the same basic principle, but things occur at different times during the lever stroke.

Locking is accomplished when the locking block is moved up behind the breechbolt as the lever is pulled back. When the locking block fits into its recess, a pin is pushed into a position that allows the trigger to release the hammer. The rifle can not be fired unless the action is fully closed. The old Winchester and Marlin lever actions utilize two-piece firing pins; the rifle cannot be fired unless they are in alignment. Alignment occurs when the locking action places the rear part of the firing pin directly behind the front one.

Savage's Model 99 is a different kind of lever action. First, it's a so-called hammerless outfit, but that only means it doesn't have an external hammer. The Model 99 uses an internal spring-loaded firing pin. Another intriguing idea that Arthur Savage came up with was the use of a rotary cartridge carrier. This design was used for generations. Instead of a plate being shoved by a compressed spring as in a tubular magazine, the cartridges were held in a spring-loaded revolving carrier. As fresh rounds were pressed into the carrier they disappeared as if by magic. A check on the count could be made through a tiny opening in the receiver where a numbered indicator showed how many cartridges were in the magazine. Currently only the Model 99C is being made, and it features a detachable cartridge clip.

The Mannlicher-Schoenauer bolt action rifle had a revolving carrier similar to the traditional M99's, and I've often wondered why more bolt

actions didn't use this design. Maybe it just wasn't necessary, as the conventional spring-loaded follower magazines and detachable box-type magazines offered no problems. I think my feelings stem from the gunsmith part of me; I like the feel of solid metal, and the carrier arrangement of the early Savage and Mannlicher-Schoenauer certainly had that.

The lever action stamped its image deep in the heart of America. From the Spencer and Henry of the Civil War through the Winchesters that "won the West," right up to the present day outfits from Browning, Savage, Winchester and others, the lever-operated rifle is still very popular. Millions of lever actions rifles have been sold and I believe most are still in use. Its popularity doesn't just ride on the fact it has an impressive historical background. Long before the advent of the slide action and autoloader, it was the only repeating action the hunter shooting from the left side could use effectively.

Winchester's versions of the lever go back long before the Model 94 rifle and the 30-30 cartridge were joined in 1895. Their Model 1866 was a revised or improved version of the Henry rifle, but its cartridge, the 44-caliber Henry Flat rimfire, left much to be desired in power, so Winchester captured the attention of hunters with the Model 1873. They stuck with the 44 caliber, but in a new centerfire version, the 44-40, which became one of our most used loads in various rifles and also the Colt Single Action Army revolver.

However, in the West, where the American buffalo and grizzly bear had to be dealt with, hunters wanted more power than this short cartridge could supply. A number of 44- and 45-caliber large capacity cartridges were introduced in this general time period for the Sharps and other single shot rifles. There was no way an equivalent load could be crammed into the M73. The little Winchester did offer a large magazine capacity and thus rapid firing ability, and that served well for fighting Indians and others, but no buffalo hunter would trade the power of his big Sharps for the firing speed of the M73.

Winchester's next venture was the Model 1876, the so-called Centennial Model. It was essentially an enlarged M73, and its original chambering was for the 45-75 Winchester cartridge which used a 350-gr. bullet at almost 1400 feet per second. That was a notable step up in power. Still, the M76 was not a strong action, and a decade later, after producing quite a few bolt action repeaters under the Hotchkiss patent, Winchester introduced one of the great lever actions of all time, the Model 1886. It had plenty of strength to handle loads of the 45-70 class, and did so for a half-century of production time. In fact, a good number of M86s are still serving woods hunters who know a good thing when they have it.

A few years later the M1892 lever gun was brought out. It handled smaller cartridges such as the 38-40 and 44-40, and gained great popularity, but nothing like that accorded the M94, which followed it two years later. This new model was the first to be designed for smokeless powder ammunition, and with it came the now legendary 30-30 cartridge, the most popular of several offered in this gun. There's little doubt that the 30-30 has killed more deer than any other cartridge, maybe more than all others put together, and it's still accounting for vast numbers every season.

The next year, 1895, brought a lever gun capable of handling the continent's largest game when Winchester introduced a completely different design, the box magazine Model 95. In addition to various black powder cartridges, it was offered in such calibers as 30-06 and 405 Winchester, the latter a favorite of Teddy Roosevelt for lions — the African kind — so its efficiency is obvious.

Marlin got into the centerfire lever action fray in 1893 with their M93, the direct ancestor of the very popular rifle we now know as the Model 336. There had been earlier Marlins — the Models 1881 and 1888, the M1889 which was the first side-ejecting lever action, the M91 22 rimfire and the similar M92 in 22 and 32 calibers, but the M93 somehow seems the most important of the early ones. There was a distinct difference between Winchester's 94 and Marlin's 336. The Winchester ejected its fired cases straight up, while Marlin used a system that ejected them out of the right side. One way is as good as the other when iron sights are used, but when scopes became popular it was not possible to mount one low and centered over the Winchester action because the up-tossed empty would hit it. The Marlin made things much easier for the gunsmith as the scope could be directly over the action in line with the barrel, while on the Winchester the scope was usually offset to the left. This required the Winchester shooter to keep his face slightly away from the stock, a definite drawback. I drilled and tapped dozens of 94s, and I dreamed up several designs for a better approach, but nothing worthwhile came from my efforts. Before side bases that required no drilling or tapping were available, I stuck with the Williams mount. I liked it because it had an eccentric bushing in the base which permitted some windage adjustment.

Another problem with the Winchester was that the scope had to be rotated 90 degrees to get the windage knob out of the way of the ejected empty. This meant the elevation knob was now located on the left side, making it the windage, while the windage knob ended up on top and became the elevation adjusting knob. This simple move often confused the owner when he tried to zero in. Eventually, after a period of trial and error, things got sorted out

and he scratched the appropriate directions on the dials. With the scope in its new position, a counterclockwise movement of the top dial usually moved the point of impact up, and a counterclockwise movement of the side dial moved impact to the left. I say "usually," because there were scopes where just the reverse was true. And of course such scope rotation was possible only with certain reticle types, such as the crosswire, duplex and center dot. A conventional post and crosswire did not permit this change because it would make the post horizontal rather than vertical.

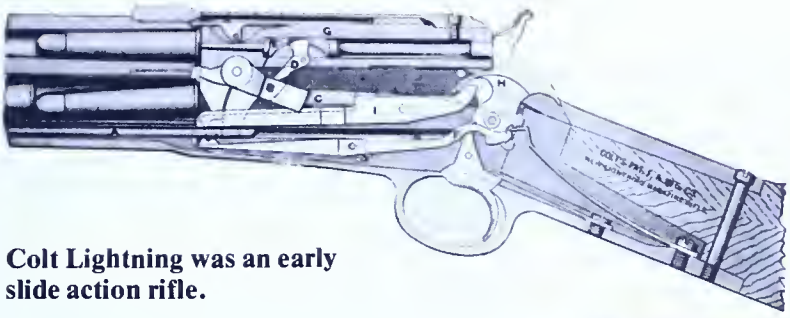
Several interesting mounting jobs evolved from the M94's straight-up ejection system. A silver haired lady hunter brought back a 94 I had just scoped. She wanted to know if I could install the scope on the right side instead of the left. I told her I never done it, but if she didn't mind the extra holes in the sidewall of the action, I was willing to try. She thought it would stabilize the rifle if she could press her face tightly on the low comb of the stock. I warned her about recoil, but she said that was not a factor.

It was a different looking 94 to say the least, but she shot it for a half a dozen seasons with good success. During the years I had my gun shop, I mounted three or four scopes on the right side of 94s.

The incident I still find hard to believe involved a Model 94 whose owner had been seriously injured in a car accident. He was unable to move his head left or right and had to wear a special brace. He told me several gunsmiths had refused to tackle the job he wanted. When he demonstrated what he meant, I could see it would require more than just drilling the receiver, and could understand why the other gunsmiths had been apprehensive. I told him he might be better off without a scope, but he was determined. He wanted it mounted on the left side an inch or more from the action and parallel to it. I had no idea what I was getting into, but told him I'd try it. I suggested he leave his 94 for a week or so to allow me time to make drawings and work out a design. He left with renewed hope, and I sat down in my old swivel chair to ponder what I had gotten into.

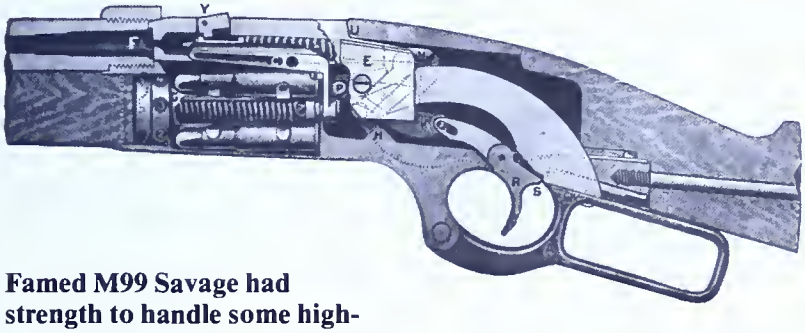
Time has erased the exact procedure I came up with, but the end result was an odd looking Model 94. The scope didn't appear to be part of the rifle; it looked more like a small spotting scope attached alongside the action. A friend who stopped by when I was zeroing it in asked if one fellow looked through the scope while another pulled the trigger. It wasn't that bad, and it zeroed in okay. The owner was elated that he could see through the scope without undue stress. I wasn't sure how I felt. It was great that the job turned out a success and the man could hunt again, but from a gunsmith's point of view, I had mixed emotions.

In 1955, Winchester offered a lever action that was decidedly different from their traditional models. The new one was the hammerless Model 88,

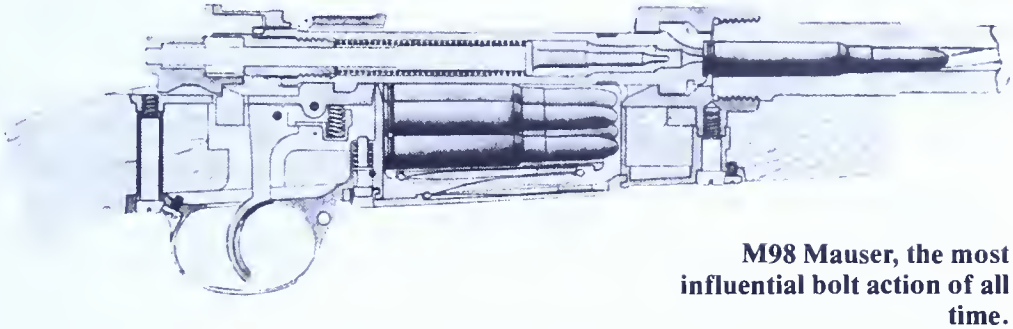


Colt Lightning was an early slide action rifle.

M73 Winchester, one of the legendary lever action rifles.



Famed M99 Savage had strength to handle some high-intensity loads.



M98 Mauser, the most influential bolt action of all time.

In the early days of the repeating rifle in America, the lever action was the most popular type, with millions sold by Winchester, Marlin and Savage. Later, as the demand for high-intensity cartridges and scope sights grew, the bolt action took over.

which had a rotating 3-lug front-locking bolt, a detachable magazine, and a one-piece stock. In silhouette, it resembled a 99 Savage more than any previous Winchester. Its solid lockup permitted chambering for such high intensity cartridges as the 243, 284 and 308. Empties were ejected to the side, so mounting a scope was easy. Normal barrel length was 22 inches, but a 19-inch carbine also was made.

Another variation on the lever guns was the hammerless Sako Finnwolf, which also had a detachable box magazine and one-piece stock and an interesting gear-operated short-throw lever. Like the 88 Winchester, the Finnwolf has faded from the scene.

A still-different design seems to have made it. The Browning BLR is a comparatively new entry in the lever action field. It came on the market about 1971. Externally it resembles the earlier visible-hammer Winchester and Marlin carbines, though it doesn't have the underslung full-length magazine. In fact, it has a detachable box magazine, which allows the use of spitzer bullets, much as the 99C Savage does. Other significant differences are a rack-and-pinion arrangement which operates the breechbolt when the lever is functioned, and a multiple-lug rotating bolt head which is recessed to enclose the cartridge head. This is a strong modern system which is enhanced by side ejection and a solid receiver top which makes it easy to mount a scope low and centrally. A scope makes a lot of sense on the BLR, too, as it is chambered for such high intensity loads as the 243, 7mm-08, and 308 and is accurate enough to take full advantage of these high velocity loads. Three-shot groups well under 2 moa are not uncommon with the BLR.

The Slide Action

The slide action, or pump, is the fastest manually operated system. Autoloaders are faster firing, but an experienced trombone shooter can put up a fair battle in rattling out the empties, especially if we are talking about aimed shots. This characteristic has made the slide action a favorite with countless hunters who shoot fast moving game at woods ranges, particularly whitetails in their normal habitat. The usual centerfire cartridges used in slide actions are in the power class suited to deer and black bear also. Some of the modern designs are capable of handling the higher pressure loads suited for elk, moose and similar size game, but for generations such cartridges could not be used in these guns.

The Colt New Lightning magazine rifle, introduced about 1885 and made in both 22 rimfire and for a number of large centerfire loads such as the 44-40, 45-60 and even 50-95, was an early successful pump gun though it was made for less than a decade. The John Browning-designed Model 1890 22

rimfire was even more successful, being in production for four decades. The centerfires came into their own in 1912 when Remington marketed their Model 14, which was updated into the M141 in 1936. The M14 was chambered for several Remington cartridges — the 25, 30 and 32 — which were essentially rimless versions of then-existing Winchester cartridges. Later the 25-caliber was dropped and the 35 Remington added, and the three larger calibers were continued in the M141. The 35 became by far the most popular chambering, and solidified the M141's reputation as an excellent woods rifle for deer and black bear. Some even used it for elk, which was stretching things a bit, but it was usually easy to get several shots into the critter in a hurry, so it often worked out okay.

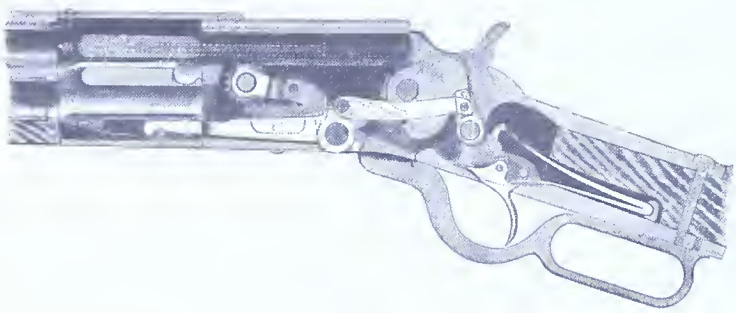
Remington used a tubular magazine in the M14/141, but solved the spitzer bullet/primer problem which plagued the early lever actions by using a spiral-type tube which positioned the cartridges so there wasn't any possibility of bullet-to-primer contact. Truth is, though, the cartridges for which these guns were chambered were best served by round nose bullets, not spitzers.

In the feeding operation of these early slide actions, the carrier lifts up, placing a fresh round ahead of the bolt. As the slide is pushed forward, the bolt picks up the loaded round and pushes it into the chamber. The action is locked, and an integral mechanism keeps the slide in the forward position. If not locked, the slide could move back, partly opening the action, and the rifle would fail to fire. The slide can be pulled back without firing by pushing a release button or lever under the action.

When a pump is fired, the slide action lock drops down, allowing the slide to be pulled backwards. This unlocks the breechbolt, extracts the case, cocks an internal hammer and, as the slide reaches the end of its rearward travel, ejects the case through a port in the side of the action. Pushing the slide forward chambers the next round. This is a slick and easy system to use.

In 1950, Remington introduced a brand new slide action called the Model 760. This was a major improvement. The older models were not strong enough to handle modern high pressure cartridges, but the new 760 had a multiple lug rotating bolt that locked solidly and allowed it to be chambered for both the 270 Winchester and 30-06.

I believe the Model 760's most appealing feature for the big game hunters was its clip, or to be technically correct, its detachable magazine. Today's hunter is mobile. The era of a hunter leaving camp at daybreak with a sandwich and a thermos of hot coffee in his game pocket, intending to stay all day in the woods, is past. Many modern hunters, for better or worse, hunt in two or three locales on the same day. No matter how deep the snow or how bad the roads, a 4-wheel-drive can take the hunter from spot to spot.



The Bullard repeater was another early lever action. It was unusual in that it used a rack and pinion arrangement to function the bolt.

Consequently, a lot of rifle unloading and loading takes place. Bolt actions and long tube lever actions are somewhat difficult to unload, but it's a breeze with a detachable magazine — just drop out the magazine and open the action to remove the round from the chamber. Some lever and bolt action rifles now have detachable magazines too.

Like the lever, the pump gave the left-handed shooter a fast operating outfit. With a bolt, the southpaw had to either lower the rifle to work the bolt or reach over the action, which was next to impossible, especially with a scope mounted. With the pump, the shooting hand firmly grasps the pistol grip and the other hand operates the slide. Both hands have a firm grip on the rifle. The operating hand will keep the same grip while the slide is worked back and forth.

I have been asked what keeps a slide action rifle from operating from sheer recoil. First, the bolt of a modern slide action is a rotating-type with locking lugs that turn into recesses in the action when the bolt is fully forward. There is also a slide-locking device that keeps the slide from coming back. On Remington's 760 or its improved version, the Model Six, the slide locking lever can be seen by looking into the magazine cut in the bottom of the action. When the rifle is fired, this lever is released, allowing the slide to be pulled back. If the shooter wants to unload without firing, the locking lever can be deactivated by a release lever protruding out of the bottom of the action. Every pump rifle or shotgun has a slide locking mechanism that can be worked manually.

There is a saying among big game pump rifle users that you have to be rough with a pump. They are referring to a well known fact that the slide on such a rifle should be worked vigorously. It may sound strange, but to make sure the pump action will extract, eject and feed properly, the slide should be yanked back and slammed forward. I can't tell you the affectionate name an

The Marlin lever action differed significantly from the Winchester, beginning with the M1889, by ejecting fired cases to the side rather than upward.

old friend of mine had for his 30-06 Model 760 Remington, but he claimed you could hear him work it for two miles on a still day.

The Autoloader

Semiautomatic (autoloading) rifles are not legal for hunting in my home state of Pennsylvania. (Neither are such pistols, though autoloading shotguns are.) Nevertheless, I want to discuss them a little just to cover the basic types of actions on the market.

Autoloaders use the force generated by recoil or the gas pressure from the burning powder to function the rifle mechanism, ejecting the fired case, cocking the rifle and feeding a loaded round into the chamber. With low pressure cartridges such as the 22 rimfire or some pistol loads, a simple blowback design can be used. With this, pure inertia (the weight of the bolt or breechblock itself) and the slight resistance of the extended recoil spring are enough to support the cartridge case and seal the rear end of the bore at the moment of firing. But the expanding gas is pushing rearward against the breechblock even as it is propelling the much lighter bullet forward, and an instant after the bullet exits the muzzle, residual gas pressure finally overcomes the breechblock's inertia and it moves all the way back, ejecting the fired case. As it moves to the rear it compresses the recoil spring which then slams it forward, picking up an unfired cartridge on the way and seating it in the chamber. Another trigger pull repeats the process. This system works well for full automatic weapons such as submachine guns, too, using cartridges as powerful as the 9mm of 45 ACP. It should be remembered that with the blowback system nothing locks the bolt, so proper functioning is largely a matter of proper internal pressures balanced against the relative weights of the bullet and the breechblock, and precise timing.

With more powerful cartridges, such as those normally used in centerfire

rifles, a locking system is required. This usually consists of lugs near the front end of the bolt, as in most bolt action rifles. These are designed to be rotated out of engagement after the internal gas pressure drops to an acceptable level, whereupon the bolt functions, as described above, reloading the chamber. In most of today's autoloading centerfire rifles, the operating force is supplied by gas pressure bled out of the bore via a hole near the muzzle. It shoves a rod back to function the mechanism. The M1 rifle which many of us used during World War II is close to the epitome of this semiautomatic design. Its correct name, incidentally, is United States Rifle, Caliber 30 M1. It was designed and developed by John C. Garand, who worked on it for the Ordnance Department from 1919 to the mid-'30s. That explains why many of us commonly called it the Garand rifle. It was undoubtedly the greatest infantry rifle that had been produced to the time of that war. Maybe it still is. I'd have a hard time naming a better one.

The M1's bleed hole was close to the muzzle, and the operating rod moved about 3/8-inch before it contacted the bolt. That free movement generated a number of stories. One I recall said that the rod had to have some free play to keep it from smashing the bolt, but that wasn't true. The free play, if I may call it that, figured in the time period needed for the bullet to get out of the barrel before the operating rod made contact and unlocked the bolt. Those who claimed the M1's bolt was unlocked before the bullet got out of the barrel were wrong.

I might point out that despite claims to the contrary, using gas to operate the M1 or any other rifle does not significantly reduce bullet velocity. I know of several cases where M1s were "permanently fixed" so they couldn't be functioned by the gas. In both cases, I was told the rifle would have extra power. It didn't.

I can't mention the M1 Garand without making some comment about the 30-caliber Carbine (the United States Carbine, Caliber 30 M1). I often shot the Garand on the range, but I carried the Carbine in Europe, and I have both bad and good recollections.

My first association with the Carbine was in Camp Gruber, Oklahoma, when the 42nd Infantry (Rainbow) Division was reactivated. I was assigned to the finance office, and we were issued the 30-caliber Carbine. There was nothing wrong with that except mine had a flaw. During the drilling of the barrel's gas port just ahead of the receiver, a chip had been knocked out of the bore when the drill bit broke through. At least that is what I think happened. This caused me problems every time we had an inspection. The area around the gas port had a dark spot which most inspecting officers mistook for dirt. I knew enough about guns to make an explanation which

usually got me off the hook and saved me from getting gigged. But that didn't always work, and I was unable to get a different weapon issued to me. Now and then, I ran into a problem.

Most of my punishment was insignificant — like leading the company in calisthenics. I didn't mind that, but when a certain new lieutenant (I wish I could remember his name) "barracked" me for the entire weekend, I erupted in a manner unbecoming a mere sergeant. He was fresh out of Officers Candidate School and figuratively drunk with power. He was furious at my outburst and promised me everything short of the firing squad. I suggested we allow the captain to decide, and for some reason he took me up on it. In a flash, he headed for the orderly room to file his charges, and I was right on his heels carrying my Carbine.

I knew I was deep in the mire, but I was mad and I intended to get justice or be court-martialed. Believe it or not, the captain immediately saw the problem. He handed my Carbine to the lieutenant and asked rather disgustedly if he couldn't see where a chip had been knocked out. The lieutenant apparently recognized that he was on shaky ground and, after a careful look, said he was aware of the chipped area but the dirt he had gigged me on was now gone. He was lying through his teeth.

Maybe the captain didn't care for the lieutenant, or maybe he felt I had been hit too hard. No matter what, I left with my pass renewed and a smile as wide as the state of Oklahoma. The lieutenant wasn't around too long.

When the war ended in Europe and things began to get back to normal, I had time to go from Salzburg, Austria, into Germany to hunt for the small red deer. I shot a number of these deer with my Carbine to help feed a few of the displaced persons who had been brought from other countries to work in Germany and Austria. Just before Christmas, 1945, three of us connected on at least two dozen deer. It gave the mess sergeant a supplemental meat supply, and some homeless men and women enjoyed the rewards of our shooting and the dependable impinging gas operating system of the 30-caliber Carbine.

In case you're not familiar with that term, impinging means the operating rod in the Carbine was driven about $^{3}/_{16}$-inch by the gas pressure before it sharply struck the operating mechanism. As with all repeating systems, the empty case was extracted and ejected and the hammer cocked as the bolt moved back. Spring pressure forced the bolt ahead again, putting a fresh round in the chamber.

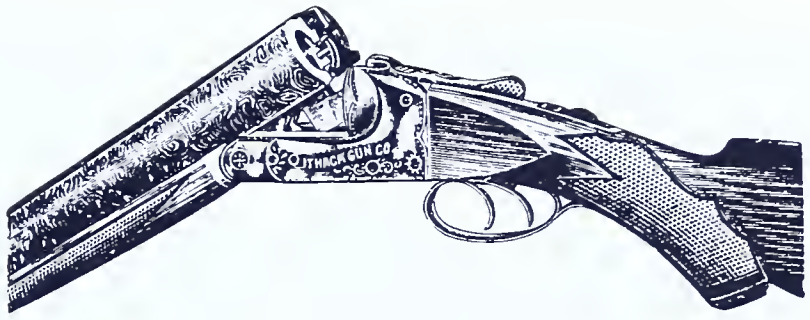
Maybe it's no more necessary to know exactly how a rifle operates to fire it than it's necessary to know how a car operates to drive it. Still, the more knowledge you have about your rifle, the better off you'll be if a problem arises.

Barrels

DURING THE YEARS I repaired guns, I often thought about firearm development. As I worked with the complex parts of semiautomatic firearms, my mind would go back six centuries to the time of the first crude cannons. The word cannon comes from the Latin *canna,* which means reed. Those tubes of wood or cast metal were the early prototypes of today's barrels. Smaller versions, called hand cannons, could be carried and fired by individual soldiers. Transition from those crude hand cannons to the shoulder weapon was not instantaneous. The pressure created by the burning powder would many times blow such devices to bits, and that certainly would dampen any enthusiasm toward the hand-held versions. Some early barrels were made of wood wrapped with strapping or wire, and there was no way of knowing when the contraption would come apart. The life of a cannoneer was indeed hazardous.

Eventually, better metals were used as technology in the field developed. During those years, when a barrel ruptured poor workmanship was normally blamed, but a German named Nicholas Bis decided that was not always the case. He felt the metal was sometimes at fault. His research for a superior metal led him to use common horseshoes. By heating the metal and working it over and over, Bis produced a metal stronger than most. In was an arduous task, but results proved his approach was correct, and it was copied by other barrel makers of that era.

I can imagine the frustrations that plagued those early gun builders when it came to barrel making. They didn't have a Pratt & Whitney rifling machine. There was no way to make a hole through the length of a bar of barrel iron. The only alternative was to wrap wire around a mandrel and forge weld it by heating it red hot and hammering it into one solid tube, then withdrawing the mandrel. If the welds weren't nearly perfect, the barrel would rupture.



Early Ithaca 1½ grade was made with Damascus steel barrels of beautiful pattern.

We erroneously group all wrapped barrels under the term "Damascus." There is a difference between a wire-wrapped barrel and a true Damascus. A Damascus barrel is made by heating and hammering strips of metal into large ones, wrapping these around a mandrel and hammer forging them into a unit. That produced a superior barrel, and also a very beautiful one. However, it was easier just to wrap wire around a mandrel and hope the hammered welds would hold. While this mating of various iron and metal strips made a beautiful barrel, there was no guarantee of its strength. I have been told that a Damascus barrel could be checked by hanging it on a wire and tapping it with a small hammer. The sound produced is supposed to indicate if the barrel has a flaw. It might be true that a dull or flat tone indicates a flaw, but I doubt that a bell-like tone is a guarantee the barrel is safe. The Damascus-type barrel is a product of the black powder era. It can't be expected to withstand the high pressures of today's ammunition. No matter how strong some of those old guns look, it's not wise to shoot them now. The best place for one is above the mantle or decorating a den.

Of all the parts in a firearm, the barrel is the most difficult to make. First, it's extremely difficult to drill a straight hole of the correct diameter in the center of a 30-inch bar of steel. Keeping a bit on true course over that much distance is a formidable task that requires top equipment and plenty of skill on the operator's part. Come right down to it, it's next to impossible, and many times there will be some runout during this operation. One barrel maker told me when he got a barrel that had a perfectly straight hole after being drilled, reamed and polished, he stamped it "Grade A" and charged more for it even though it was just good fortune the hole was straight.

If the hole isn't straight, it can be made so by one or more forms of "bending." The straightening device applies heavy pressure on that part of the barrel that needs to be trued, while the opposite side of the barrel is held

solidly in two places bracketing the pressure point. The operator watches a shadow line to determine when the barrel is straight. On some types of lathes that will suspend the barrel though the headstock, the operator can look through the bore of the spinning barrel for curves or other off-center signs. A machinist/gunsmith friend demonstrated this to me, and I could detect the off-center section immediately. Some shooters are dubious about a barrel they believe has been "stressed" this way, but there is no evidence to prove a barrel that has been straightened won't shoot accurately. In fact, they usually do quite well, and from a hunter's viewpoint there is nothing to worry about.

After a barrel is drilled and reamed, the outside of the steel bar is turned on a lathe to make it concentric with the bore. The means the barrel wall thickness will be the same around the bore. This is a must or the side that is thin will heat up quicker than the side that is thick, a condition that might make a barrel "walk."

Perhaps there is a little justification in fearing a straightened barrel. There is always the possibility it might return to its original curve as it heats up. Several barrel makers tell me they reheat straightened barrels and allow them to cool. Then the outside is turned concentric with the bore.

Some shooters feel the non-concentric barrel is not all that bad. One famous barrel maker said he had made barrels for customers in England that were purposely machined to have more metal on one side than the other. He felt this was more a personal whim than a contribution to accuracy. From my point of view, I'll take the straightest, most uniform barrel I can get. I want everything possible in the way of accuracy.

The first problem encountered by the barrel maker is getting the hole through the steel bar. Generally speaking, a V-shaped drill is attached to a V-shaped rod. The V in the rod runs its entire length. It is turned at a high speed, and advanced slowly into the barrel blank. Oil is pushed through a hole in the rod. It aids in cutting and also carries the metal chips out of the barrel in the V-groove. Barrel drilling is certainly not as slow as the old days, but it is not a 15-minute job, either.

When it was learned that cutting spiral grooves in the bore improved accuracy, the early craftsman had a real job on his hands. I don't know how the earliest rifling was done. The muzzleloader barrel maker used simple equipment to cut shallow grooves in the bore. He used a very slow twist of about one turn in 48 inches. A wooden rod with a cutter on the end was pulled through the bore. Either the barrel was turned or the rod rotated to correspond with the rate of twist desired. It was a time consuming job that took not just hours, but days. To make the cutter bite deeper, a piece of straw was placed under it. The rod was pulled through the bore until it would not

Some years ago I discussed barrel making with Clyde Hart at his Lafayette, NY, shop. In the era following WWII, Clyde and his brother Bob made many of the highest quality benchrest barrels ever produced. Countless records were fired with their stainless steel barrels.

remove any more metal; then it was adjusted to bite deeper, and the whole process started over again. A local black powder historian told me that in one Pennsylvanian's barrel shop there was evidence that the floor in front of the barrel cutting device had been rebuilt five times. Countless thousands of steps, walking back and forth over the metal bits on the oil-soaked floor, had cut through the floorboards.

Almost all barrels were rifled by the cutting system until the early 1950s. The procedure was similar to that used by the early barrel makers, except the cutting tools were more refined. After World War II, a system called button rifling was introduced. A button is a small, extremely hard carbide unit whose surface is a mirror image of the rifle bore's interior. That is, the lands on the button create the grooves in the bore when the button is either pushed or pulled through. Metal is not removed with the buttoning process; it is displaced. A helix on the button determines the rate of twist. Rifling a barrel with the button method requires only seconds and produces a very smooth bore.

Many of today's makers and shooters claim button rifling is superior to the old cutting method. I discussed this with the late Clyde Hart, world renowned barrel maker, and he didn't fully agree. Even though he used the button system, he said either method, if done properly, gave excellent results. Benchrest shooting seems to prove that.

One interesting type of rifling is called "accelerated twist" or "gain twist." The rifling immediately in front of the throat (some call the throat area the "leade") starts out with a very slow rate of twist and accelerates as it

Rifling a barrel is not a simple procedure, but there are several ways to do it and all work well if properly done. Though rifling might seem a minor change from a smoothbore, it was a quantum leap forward in making firearms accurate.

moves toward the muzzle. There used to be talk about its advantages, but from what I can gather it has little exciting to offer. In the days when lead bullets were used exclusively in rifles, such rifling might have put less stress on them as they gained velocity in the bore, making them less likely to strip in the rifling. With jacketed bullets, this is rarely if ever a problem.

Arguments still go on about rifling, and some claim the number of grooves determines how accurate a barrel will be. That's debatable. Possibly it could be determined that for a given caliber, weight and style of bullet, at a given velocity, a certain number of grooves might be the optimum. But this doubtless would require long testing in a number of benchrest-quality barrels, and then the results would mean nothing to 99+ percent of the shooters as the differences would probably be small fractions of an inch. Basically, it goes back to workmanship, as Clyde Hart pointed out to me years ago. As an example, before World War II I believe most centerfire rifles had 4-groove rifling, but to speed up production of the M1903A3 Springfields in the early 1940s, many were made with 2 grooves, with no significant loss of accuracy.

Going to the other extreme, Marlin has long claimed that their Micro Groove system, which uses a large number of comparatively shallow grooves, is superior. They say this method grips the bullet tighter but deforms the jacket less, resulting in better accuracy. I should go a step further and point out that to have shallower grooves means that bore diameter will have to be larger in a given caliber barrel. For instance, in a conventional 30-caliber setup, bore diameter is .300 and grooves are cut .004 deep on opposing sides, making a groove diameter of .308, which is the actual diameter of a 30-caliber bullet. Thus the metal remaining between the grooves — the lands — grips the bullet and makes it follow the spiral path of

the rifling, imparting a spin which stabilizes it during its flight through the air. With the Marlin setup, where the grooves are perhaps .003 deep, bore diameter may be .302 or so. The thing is, groove diameter should exactly equal bullet diameter. This gives the least bullet deformation, which helps accuracy.

One of the most controversial factors pertaining to the rifle barrel is its length. Barrel length is not as important as many shooters (especially hunters) feel. It is not necessarily true that long barrels are more accurate than short ones. Ballistic experts do agree that longer barrels usually increase velocity with a given load but, again, not nearly as much as has often been touted. I have chronographed many rifles and, so far as I'm concerned, adding barrel length just to gain velocity is not worth the money. Years back, I believed the long barrel theory, and some of my plans for the perfect woodchuck rifle called for a 30-inch barrel. But over the decades I've concluded a 24-inch barrel is ideal on a varmint rifle. The deer rifle can have a barrel several inches shorter than that and still meet all normal accuracy and velocity requirements. It's really a foolish argument when only two or three inches of barrel length are being considered. Let's say that at 3000 feet per second an extra inch of barrel adds 30 fps to the velocity. Three inches would up the velocity 90 fps. Surprisingly, it's not unusual to have a 90-fps spread between two cartridges loaded with the same primer/powder/bullet combination. I have seen even greater velocity differences while chronographing both handloads and factory rounds. And this much velocity increase makes almost no noticeable difference in trajectory at hunting ranges.

One barrel demon that is often discussed but seldom understood by casual shooters is headspace. In layman's terms, headspace is the maximum distance possible between the bolt face and the head of the case when the cartridge is fully seated in the chamber and the bolt is closed and locked. Another definition says it is the distance between the bolt face and that part of the chamber which prevents the cartridge from moving in deeper. Actually, headspace is measured from the bolt face to that portion of the chamber that supports the cartridge, and this measurement varies significantly among the different types of cartridges.

On rimmed cases such as the 30-30 Winchester and 30-40 Krag, the front face of the rim makes contact with a recess cut around the chamber entrance to keep the cartridge from moving deeper into the chamber. A similar situation exists with belted magnum cases, where the front face of the belt acts as the stopper. On rimless cartridges such as the 30-06, 270 and 243, the shoulder bucks up against the matching coned surface of the chamber, while

on straightwalled cases such as the 45 ACP the case mouth contacts a thin ledge left at the rear end of the bore when the chamber is cut.

If a chamber is cut too shallow, the cartridge cannot be fully seated and thus the bolt cannot be closed. On the other hand, if the chamber is cut too deep the space between the bolt face and the case head will be in excess of acceptable tolerances and the bolt will not properly support the case. When the cartridge is fired, gas pressure will force the case head back against the bolt face at the same time that the case shoulder is being held against the front coned surface. Obviously the soft brass case will be stretched lengthways. This can cause a circumferential crack, usually near the head of the case where it thins down to meet the case wall, and release gas at perhaps 50,000 psi pressure into the rifle action and possibly back into the shooter's face. Knowing this, it isn't hard to understand why headspace is an important subject.

Headspace tolerances vary slightly, but it's generally accepted that the space or distance between the face of the closed bolt and the case head of the fully seated cartridge shouldn't be more than .006 (six thousandths of an inch).

I think it's evident that excess headspace can be caused by a poorly cut chamber or an improperly sized case. It's wise to keep on the lookout for signs of excessive headspace when using reduced loads in rimless cases. A reduced powder charge may not create enough pressure to fully expand the case, and the heavy blow from the firing pin can drive the case forward — and thus the shoulder backwards — a few thousandths of an inch. The result is a headspace problem. I have never seen this, but a friend who is an avid reduced load fan claims it can and does happen.

It's safe to say that few shooters know everything that takes place in a rifle barrel when the shot is fired. Maybe that doesn't matter as nothing can be seen except possibly a small flash of fire and a puff of smoke at the muzzle. Yet in the splintered part of a second from the time the primer ignites the powder until the gases push the bullet out of the case and through the bore, a lot of things happen.

With the intense heat created by the burning powder and to a lesser extent the friction caused by the bullet being forced through the rifling, a toll is taken; in reality, barrel life is shortened. The initial heat is greater than the melting point of steel. This temperature lasts for only an instant; nevertheless, a minute amount of metal in the barrel's throat is removed with every shot. This is called erosion and, the hotter the load, the quicker the erosion ruins the throat.

During the upgrading of the barrel industry, steel quality was also on the

Some of the equipment used when chambering a rifle barrel — finishing reamer with integral throater, left, headspace gauges standing behind reamer, and micrometer, right. There is little room for error in chambering; a few thousandths of an inch are important.

upswing. I have already mentioned that the soft steel of the early musket days would be no match for today's smokeless powders. Many of today's barrels are made from 4140 SAE (Society of Automotive Engineers) steel. Some barrel manufacturers make chrome-moly barrels; these are of steel which has had chromium and molybdenum added to it. Chrome-moly steel is strong, durable enough to withstand high heat and pressure, and easy to machine. In recent years many barrels have been made of stainless steel.

The internal dimensions of a barrel can be measured in thousandths, or ten-thousandths, of an inch. The thing no one can predict is the accuracy life of a barrel. I've been asked that question more times than I can remember. Yet there's no way of knowing in advance how many shots of acceptable accuracy any barrel will give. I can escape the question by saying that it depends on how a barrel is treated and taken care of. A number of shots fired rapidly are much harder on a barrel than the same number spread out over a long period. Also, high velocity loads have more effect than slow ones, and jacketed bullets cause faster barrel wear than lead ones. Even that doesn't give a specific answer. For all practical purposes, it will remain a mystery, but we do know more today about a barrel's interior than before.

We tend to think a barrel problem is caused only by overheating or using so-called hot loads, those near or exceeding the maximum powder charges shown in reloading manuals (which I must say is a dangerous practice). We often casually say an inaccurate barrel has been shot out. But what does shot

out mean? Here again we are up to our necks in a complex situation. Only a barrel specialist can really judge the condition of a barrel's interior, and to do so requires the use of sophisticated equipment. I've often seen shooters look through a bore for a few seconds and then emphatically state that it has been shot out. But a naked eye inspection of a bore reveals very little except possibly some powder residue. Jacket fouling (a thin metallic deposit rubbed off of the bullet's jacket) is almost impossible to see without optical aid. This type of inspection is beyond the ability of most of us.

When a rifle starts to spread its groups or becomes erratic, it's often claimed that the throat is scorched and eroded. Well, it's true the bore just ahead of the chamber is a very hot spot, and that metal here is burned away bit by bit. Tiny fissures appear, and it seems possible high pressure gases might escape along them prematurely, which could affect the accuracy of the bullet — or so it has always been claimed. However new opinions are evolving from the muzzle smoke.

According to one barrel expert, Sal Ventimiglia, the maker of Shooter's Choice bore cleaning solution, throat erosion is not the Achilles' heel of accuracy. While there's no question the erosion and fissures appear, Ventimiglia feels it's not escaping gases that destroy a bullet's accuracy but tiny bits of jacket that the rough throat rips off, which in turn upsets the balance of the bullet. He adds a real kicker with his belief that only a few inches of good bore at the muzzle are needed to make a bullet fly a true course if the bullet is not deformed or damaged before it reaches that part of the barrel. He also claims that many barrels which are thought to be shot out could easily be revitalized by simply getting jacket buildup out of the bore.

A buildup of jacket material on a rough spot in the bore will have a definite impact on how true a bullet flies. Benchrest shooters know this, and constantly clean their rifles. When a bullet hits a buildup of metal in the bore, some of its jacket is ripped off, affecting the perfection of its balance. When a bullet is slightly heavier on one side than the other, it cannot rotate smoothly. I saw a perfect example of this while watching a specialist true a new driveshaft on a lathe. Spinning the driveshaft at high speed produced enough wobble to swing the dial indicator's hand wildly. The shaft was out of balance. By applying heat to a particular spot, the man reduced the shaft's wobble until the indicator showed little runout. Similarly, an unbalanced bullet will not rotate smoothly and accuracy will suffer.

Ventimiglia's theory might not be accepted by everyone, but he is a national benchrest champion and has had several decades of barrel cleaning experience. I take his observations seriously.

Stocks

THE STOCK ON a rifle or shotgun is surrounded by more controversy than any other aspect of a firearm. Wood has been, and still is, the predominant stock material, and right here is where the arguments, opinions and disagreements begin. Almost any statement made in regard to a stock will be immediately challenged. Just say that California claro walnut is only half as good as English walnut, and tempers rise. Put two veteran stockmakers in the same workshop, and they'll probably not be speaking to each other by the end of the day.

To make matters more complicated, stocks of man made materials such as fiberglass are gaining popularity nowadays. Some shooting experts say fiberglass and Kevlar stocks are better than wood. Let me give you a little advice: never mention either when standing near an old wood stockmaker who has a checkering tool in his hand. Chances are you'll have 28 lines to the inch somewhere on your anatomy.

Many shooters judge a stock by its beauty. But we all know that beauty is in the eye of the beholder. Nevertheless, though it might seem a ridiculous way to judge a stock, countless gun owners think only in terms of the figure and color in a stock. Place a plain stocked rifle next to a fancy job, on the same model rifle, and the highly figured stock will move first, even at a higher price. Stocks have a way of catching a shooter's eye. I guess that's only human nature.

The modern gun stock didn't attain its sleek configuration in a matter of a few years; the basic evolution of the shoulder stock took a century or more after the development of the hand-held firearm. For perhaps a century after black powder was discovered, it was used in primitive cannons. Those monsters were for knocking down walls; they were of little use against

charging infantrymen. Gunmakers gradually began making guns designed to fire smaller projectiles, and this meant the gun had to be held by the shooter.

The wood stock or "tiller" came on the scene in the mid-1300s. The tiller, a sort of pole as much as four feet long, was attached to the barrel. As barrels got longer, stocks got shorter. Sometime around 1450, the hand-held firearm had a barrel and stock. It was crude, but it was the beginning of our modern shoulder gun. By the 16th century, stocks were showing curved butts and a cut out section for the thumb on the shooting hand to fit around. Eventually it became apparent that a properly designed stock was necessary for convenient gun handling, and that it made hitting easier. Gun designers began to mate the stock with the type of shooting the gun was being used for. It was obvious by the early 1900s that not only the design but also the weight and dimensions of the stock were important.

A stock is not just a hunk of wood that holds all the metal parts of a rifle or shotgun. It isn't just a piece of wood to place against the shooter's shoulder, either. A gunstock has a specific purpose, is designed for that purpose, and it has a nonmenclature of its own.

At the rear end of the stock is the buttplate, normally a plate of metal or plastic, or a rubber recoil pad. If the gun has a two-piece stock, the butt is often referred to as the busttstock, and the forward piece is called the fore-end or forearm. No matter what the rear part of the stock is called, it's the end that nestles into the shoulder pocket.

The buttplate is nothing more than a protective shield, though it sometimes adds a little to the looks of the stock. Military stocks often have a metal buttplate that wraps around the toe and heel of the stock. I might point out here that the heel of the stock is the top rear corner of the butt when the gun is in firing position, and the toe is the bottom corner.

A recoil pad does exactly what the name implies. It absorbs recoil. These pads come in many styles, from a solid half-inch piece of rubber to thick corrugated collapsible types. There is even a slip-on boot which can be used to add length if needed.

The top line of the butt is known as the comb. Its front end, where the stock line dips down to make room for the thumb, is called the point or nose of the comb. Normally the comb slants downward to the rear, giving more "drop" at the heel than at the comb nose. This is necessary because the buttplate makes contact with the shoulder pocket during aiming, and the shoulder is lower than the face, which rests against the comb and the forward side of the buttstock. Ideally, the height of that portion of the stock which supports the face should be the same distance below the line of sight as the lower edge of the cheekbone is below the shooter's eye. It was easy to get

Top stockmaker Jim Peightal and I discuss how much he'll shorten the stock on my 20-gauge SKB and whether the pitch should be changed at all. He'll also replace the original buttplate with a thin rubber one to eliminate slippage.

such dimensions with an iron-sighted rifle, as the sights were installed directly upon the barrel or the action and the barrel. But when scope sights began to gain popularity, their diameter plus the height of their mounts necessitated a higher line of sight. In order to raise the eye high enough to see easily through the scope while the face was properly supported, it was necessary to make the stock comb higher. Such a design is usually called a Monte Carlo comb. I've heard that the term derives from that part of the Mediterranean where much live bird shooting has been done over the years. The position of the shooting eye serves as the rear sight on a shotgun and it's important that its height be the same from shot to shot, no matter how the gun is swung, so to facilitate this stockmakers made the top line of the comb straight — parallel to the bore rather than sloping downhill. The idea was adapted to many rifle stocks over the years, usually in conjunction with a cheekpiece, which is a raised surface on the side of the stock to support the face. A cheekpiece often thickens the stock a bit, which has the effect of raising the eye a trifle too.

As scopes got bigger lenses, they had to be mounted higher and higher above the gun, yet there was a limit as to how much the comb could be raised because it was necessary to function the rifle's bolt. That meant the nose of the comb could not be higher than the cocking piece when the bolt was open. In an effort to maintain the ideal relationship between face support and eye height, some stockmakers gave a reverse slope to the stock comb; that is, they made it higher at the rear than at the nose and then dropped it off abruptly at the rear. This also reduced recoil effect somewhat because when the rifle revolved upward as it kicked, the comb slid out from under the cheek rather than whacking it. As with many things, this change was carried

to foolish extremes by some stockmakers, ultimately causing a reaction against Monte Carlos in general. This led to the development of what has been called the modern classic stock, a high thick straight comb with no rear-end dropoff or cheekpiece. This is perhaps not as good for use with high-mounted scopes such as the biggest variables or target styles, but it works very well with most hunting models.

Both the comb and cheekpiece play important roles in how well we shoot a rifle, but in shotgunning the drop of the stock can be the difference between success and failure. On a shotgun, drop is usually measured vertically at two places from an imaginary line extending backwards from the top of the barrel. The first measurement, in inches, is taken to the comb nose, the second to the heel of the stock. On a rifle, drop is sometimes measured from the centerline of the bore, sometimes from the line of sight. The latter seems more logical. Regardless, the shooter's basic goal is to know which measurements suit him best and to get these, for they help him hit. Modern shotguns have less drop than those from bygone days, as this gives a built-in lead on rising birds, making it possible to hit without blotting out the target. Personally, I like more drop as I'm basically a rabbit hunter, often shooting downhill, so to speak.

Another stickler is pitch. Pitch can be described as the angle formed by the intersection of the line of bore to a line drawn through the heel and toe of the butt. This can be seen by placing the butt flat on the floor with the action touching a wall. The distance, in inches, between the wall and the muzzle represents the amount of pitch or tipdown. Both pitch and drop contribute to the vertical control of the pattern.

Cast off and cast on are other terms we don't hear much about nowadays. They refer to the amount the butt might be angled to the right or left of the gun's centerline when viewed from above. A stock is said to be cast off when it angles to the right. This makes it a bit easier for a right-handed shooter to align his eye with the gun's rib. Cast on does the same thing for a left-handed shooter.

The forearm or fore-end is the wood ahead of the action. On a double barrel and some single shot scatterguns, it's a small piece of wood that snaps against the barrels. On a one-piece stock on a rifle, it's what the barrel is inletted into. On a double barrel shotgun a fore-end has one basic purpose, to hold the gun together when it is opened. Normally, the fore-end snaps on and can be easily removed when disassembling the shotgun. Remove the fore-end and push the operating lever and, usually, you have the barrels in one hand and the stock in the other. Fore-ends also enclose parts that aid in cocking and automatic ejection.

From a shooting standpoint, the configuration of the fore-end is very important. Early shotgun fore-ends were small, but many of today's are fairly deep and wide. The beavertail fore-end is a good example of what I mean. It's wide and hand-filling. The beavertail is found on many American side-by-side shotguns, while a lot of European and English guns still use the slender narrow style often referred to as splinter fore-end. There's no question that the beavertail contributes to hitting. It provides a better grip and it keeps the forward hand farther from the hot barrels during continuous shooting. Personally, I don't care for an extra wide fore-end any more than I care for an extra thick pistol grip. But this is only my viewpoint. I am an over/under fan, and I like the thin, deep feel of the O/U's fore-end. I guess it reminds me somewhat of a rifle's.

The pistol grip on a stock is a controversial thing. Stockmakers have argued for years whether it is essential on a firearm. From my point of view, a rifle needs a pistol grip simply because it offers a firmer grasp of the stock. It's worth noting that many old military rifles such as the 1903 Springfield had straight grip stocks. I feel they were comparatively hard to control. The pistol grip aids in pulling a rifle or shotgun into the shoulder pocket. English gunbuilders argue that a stock with a straight grip allows the hand to slide back faster to pull the rear trigger on double barrel outfits. With a pistol grip, it's necessary to bend the trigger finger slightly to get to the rear trigger. The single trigger found on most two-barrel outfits today has killed that argument. A good segment of shotgunners feels the straight stock has a distinct edge in beauty. Here again, beauty is subjective. I will stick with pistol grips because I like 'em and they work.

The length of a pistol grip is measured from the face of the center of the trigger in a straight line to the front edge of the bottom of the grip. It should measure from 3 1/4 to 4 inches. Grip length theoretically should be determined by the width of the palm; however, in practice it usually is determined most by appearance. Quite often the bottom of the grip extends somewhat farther than necessary for a firm grasp, just because it would look odd if bobbed off. Pistol grip circumference varies too, depending upon the manufacturer's ideas of the average user's hand size, or perhaps according to how he believes a grip should feel. I have a friend with small hands who always complained that the grip on the original Model 70 Winchester — now revered in song and story — was far too big. For shooters who place the thumb along the side of the stock, a somewhat large grip might be desirable as it adds strength to the weakest part of the stock. But frankly, I don't think that is the correct way to hold a rifle and definitely not a shotgun. It had some popularity decades ago, particularly among riflemen who learned to

shoot on the '03 Springfield. That short-stocked low-combed rifle had a tendency to drive the thumb into the nose when fired, if it was wrapped around the grip as it should be. Modern rifles don't have that problem, so there's no logical reason not to grasp the pistol grip normally.

The fore-end of a stock plays an important role in how we shoot. On a one-piece rifle stock the fore-end is the wood directly under the barrel. How the barrel is bedded in the fore-end channel has a significant effect on the rifle's accuracy. Usually, the more perfect the fit between wood and metal here, without strain or pressure on either the stock or barrel, the better. However, some rifles shoot best when the barrels are free floating, which means that from just ahead of the receiver ring to the front end of the stock there is no contact between wood and metal. Other rifles perform best when there are pressure points between the stock and barrel to dampen vibrations. Often, on light hunting barrels, top accuracy is obtained by having the fore-end tip exert some upward pressure against the barrel. Truth is, every barrel is a law unto itself and the only way to find out how yours will shoot best is by experimenting.

Probably the most important aspect of the stock is its length of pull. Stock length is the distance from the center of the trigger to the center of the face of the buttplate or recoil pad. I know from many years of gunsmithing that incorrect stock length is the major reason most shotgunners miss. The length of a shotgun stock should be made on an individual basis, just the same as a shoe size or a prescription for eyeglasses. This problem cannot be addressed in general terms. A stock either fits or it doesn't. To my way of thinking it's as simple as that.

Shots fired from a smoothbore in the field can be described as "reflex shooting." The action takes place in a matter of seconds. There is precious little time to adjust to an over-long stock. The gun must come up in one fluid motion and the stock must fit precisely into the shoulder pocket. This won't happen with a stock that's an inch or more too long.

The long stock theory is based on the assumption that today's shooter is larger than his ancestors. He is said to be bigger, and consequently it is argued that he can successfully use a 14¼-inch or longer stock. In the Book of Numbers, Chapter 13, Moses sent spies into the land of Canaan to see what type of people lived there. They reported that the land was filled with giants, the sons of Anak. I have serious doubts that most modern hunters resemble the Anakim giants of old. Just stand on a street corner and watch the world pass by. For every six footer, you'll see a dozen or more people who fall far short of that height. It's just not logical to assume that the long stock is for every hunter.

A competitive shooter is faced with vastly different problems. His stock must be the correct length for a comfortable mount and to give the proper position of cheek on comb. The comb acts as a rear sight, so it must fit the shooter's facial contour. If it doesn't, the shooter's eye will not be correctly aligned with the rib or barrel.

The argument persists that shortening a stock destroys the balance of a shotgun or rifle. I don't believe that. Balance is another firearm term that is vague and hard to describe. My firearms dictionary says balance is "the center of gravity ... Good balance is highly desirable in a hunting gun." You see what I mean when I used the word "vague." Even with the dictionary definition, not much has been learned.

Denny Shreckengost shows me a fiberglass stock that can reduce total rifle weight by a pound or more, and also eliminate the warpage which often causes a change in point of impact.

I believe the upland hunting gun should have its weight centered between the hands and be just a whisper barrel-heavy.

The popular belief an extremely lightweight gun is a fast-handling gun is as false as a seven dollar bill. Cutting off barrels, shortening stocks or removing weight in any manner does not make a gun fast in a true sense. Due to its lightness, it may get into action quicker, but it tends to bounce when it hits the shoulder and getting the muzzle to point the same each time is a different matter. It's easy to overreact with a superlight shotgun.

Gun stocks are made from a wide variety of hardwoods. The most common in this country is black walnut. In this category, you can have anything from very plain to very fancy. Price increases with the quality of the grain and figure of course.

The best grade of walnut is English walnut, the same tree that grows the English walnuts you buy in a store. It can be called Turkish, Australian, French or even New Zealand walnut, depending upon where it grows, but it comes from the thin-shelled walnut tree. Many custom guns are stocked with English walnut, and it is expensive. There is no real shortage of good walnut, in this country or abroad. However, some of the best English grade is in remote places that are difficult to get to, cut and process, and that pushes the price up.

A few years ago there was some fear that walnut was disappearing from the scene, but that's not true. Currently there is also a fear that synthetics will replace wood stocks, but that's not true either. Stocks of fiberglass, Kevlar or other manmade materials will replace wood for some applications, but wood, and especially walnut, will be the number one choice on fine guns for decades to come. Its awesome beauty simply can't be matched.

Naturally, the stock must be suitable for the type of gun fitted into it. Magnum rifles have to have stronger, denser wood than a plinking rifle. Not every type of wood is suitable for gunstocks. Wood that warps or splits easily will defeat the purpose. Walnut is used because it possesses all the qualities required. It's strong, of reasonable density, capable of withstanding a lot of punishment, and can be breathtakingly beautiful.

We hear a lot today about claro walnut, most of which comes from California. Its characteristics are more color, figure and grain layout. Since the Californians want to grow a lot of walnuts, they irrigate their stands of walnut trees. This speeds growth and produces walnuts, but many top stockmakers claim the California walnut is not as good as blanks that come from trees that grew strictly by natural means.

American black walnut is the basic gunstock wood in this country. It varies in color from very light to very dark. Some of it has a good bit of figure, which my stockmaking friend Jim Peightal calls "Mother Nature's imperfections." Straight trees have straight grain, and crooked trees have figured grain.

Some inexpensive stocks are made of birch. Birch lacks beauty and figure, but it is durable. It's also plentiful. Another popular wood that is used mostly on black powder guns is maple. Maple is hard to work, due to having hard and soft spots, but in quilted, birdseye or tigertail configurations it can be spectacularly beautiful. To me it seems most at home on a flintlock rifle, probably because that's where it was traditionally used. Many other woods have been used for stockmaking, including cherry, myrtlewood, apple and mesquite.

Some hunters think that birch is easy to checker and stain. Actually, the opposite is true. It's difficult to hand check birch, but it does press checker well.

Selecting the right wood for a stock is not easy as most shooters know little about the subject. There is something about the grain in a stock that fascinates us all. We like curly maple or fancy black walnut, and many hunters want "feathering" or a "marble cake" effect in their stocks. Here again, we are toying with ideas, visualizing end results; few of us really know the complexities of laying out, cutting or curing stock blanks. It's a

complicated process. A blank suitable for a gun stock must be a good bit larger than the stock and it has to be sealed on the ends from the moment of cutting. Otherwise it will dry and crack.

Practically every rifle owner gets involved with a stock problem sooner or later. Some are figments of the imagination, but others are real. Many times a shooter concludes that a new stock will improve the performance of his rifle. I won't say that can't be true but, in most cases, restocking a rifle does not improve its accuracy. This is especially true if the original stock is free from cracks or other defects. Many times I think restocking a rifle falls into the same category as glass bedding. Many riflemen have come to believe that glass bedding will solve all accuracy problems. It won't. It's true that glass bedding, if properly done — which isn't as easy as it might seem — gives a nearly perfect mating between metal and wood. It's in a class by itself in that category and it can add a lot of strength, but there's no guarantee that a rifle will immediately start to shoot one-hole groups after being glassed. I have fired my share of glass bedded varmint rifles that wouldn't shoot worth a plugged nickel.

Stocks of manmade materials are gaining in popularity, after a slow start decades ago. As with many other major improvements in accuracy, it's probably fair to give the benchrest crowd the credit for proving their worth. While fiberglass is lighter than most woods, the main benefit the so-called glass stock offers is stability. Stocks of fiberglass, Kevlar and similar materials are impervious to the elements; they do not warp or bend with changing temperatures or humidity readings. On the other hand, they are not a magical cure for all shooting problems. A rifle that has barrel or action problems won't suddenly become a target outfit with the installation of a fiberglass stock. Nevertheless, they do have some advantages so any serious shooter should fully analyze their qualities to see how they might serve his needs.

Rifle stocks can be classified into two basic types: the one-piece bolt action stock and the two-piece such as pumps and levers which have an action between. When I operated my sight-in range, I learned to my surprise that a significant number of hunters would have preferred a slide action rifle but stuck with a bolt because they felt the one-piece stock made for a more accurate rifle. This is not necessarily true. A one-piece stock can be a victim of temperature and humidity changes. Some stocks tend to warp, which makes them bear unevenly against the metal parts, and this can play havoc with accuracy. I have shot a number of Remington slide action rifles that were just as accurate, if not more so, as many rifles with one-piece stocks. In all fairness to the one-piece stock, it can often be tuned by a good

stockmaker to shoot better than when it came from the factor. However, this is not a job for the inexperienced.

When repeating rifles became common in this country late in the last century, shooting styles must have been different than they are now. They had to be because stocks on rifles in those days — many of which still exist — had a lot of drop; that is, they angled downward to the rear at a significant angle. That required the shooter to keep his head erect so he could see the sights. As a result, he got little face support from the stock. Probably his jawbone made the only contact, certainly not his cheekbone. As a result, offhand was the most practicable firing position. Things worked reasonably well, though, because that's how most shooting was done on those days, particularly with the lever actions which were so important in America's shooting tradition.

Even when the bolt action 1898 Krag and 1903 Springfield came along, the comb of the stock was on the low side, though not as much so as with the levers. The change might have come about because military personnel shoot from many positions, and obviously, the proper comb height is that which fully and firmly supports the face while the aiming eye is correctly aligned with the sights. I don't think this goal was ever achieved with an American bolt action military rifle. I know the comb of the 1903-A3 was lower than I liked, and the 1917 Enfield was even worse. However, the autoloading M1 Garand of World War II days was much better, so maybe someone learned something along the way.

Many stocks being produced today have high combs on rifles carrying open sights. It's exceeding difficult to get the eye down on the same level with the sights. I have been told by several rifle manufacturers that the vast majority of these rifles will be equipped with scopes, and a high comb is necessary. That's probably true, but then why install iron sights that can't be used?

While a stock has a definite practical side, it also has an esthetic side. The stockmaker is caught between a rock and a hard place. He is required to make a stock that fits the customer, gets the best results from the firearm, and at the same time is a thing of beauty from the owner's viewpoint. That's a major undertaking. I'm impressed with how well its being done these days, at least on the better guns.

Rimfire Rifles

TYPES OF RIFLES include hunting, competition, and military. I'm going to ignore the competition and military models here and concentrate on some used for hunting, specifically the rimfires.

When we think of hunting small game with the 22, most of us think of squirrel hunting. I'm aware that in other parts of the nation the 22 is used for a variety of small game species and pests, but in Pennsylvania this rimfire falls right into the scheme of squirrel hunting, and rightfully so.

The 22 rimfire cartridge has the distinction of being the first self-contained metallic cartridge. It dates back to the French Flobert rifles of the 1800s. I am fortunate to have some excellent reference material on Floberts in the form of a monograph by retired Major Kenneth E. Harte of Allentown, Pa. According to Harte's material, Louis Nicholas August Flobert (1810-1894) of Paris, France, patented the "Flobert Rifle, Pistol, and Capsule Cartridge" on July 23, 1847. Additional patents and amendments were granted for a number of years. The Flobert rifle used a metallic cartridge. The rifle had a mechanism to open and close the breech and fire the rimmed cartridge which consisted of a formed metallic case, a rimmed base which contains the primer substance, and pellet, ball, or shot. There was no powder. The Flobert was a forerunner of today's self-contained rimfire cartridge. Floberts were manufactured by the tens of thousands in many countries and by numerous manufacturers. The sighting arrangement consisted of a small knife blade front sight and a V notch rear sight. Each sight was attached to the barrel in a tapered slot; this made windage adjustment possible by tapping left or right. Harte says that the major manufacturer possibly was H. Peiper, in Belgium.

Harte describes many Floberts. An example is his No. 2 Model, serial number 155, which had a 22-inch octagon smoothbore barrel with a single

mule ear, finger-operated extractor. Caliber was 22 BB Cap (Bulleted Breech Cap) and 22 CB Cap (Conical Bullet Cap). Overall length, 38-inches.

The Flobert rifle was called a parlor gun. Back then in Europe, indoor shooting was popular, and the low power of the Flobert BB cap made it reasonably safe to shoot in parlors and living rooms with a suitable backstop. The Flobert self-contained cartridge helped set the stage for the 22 Short, which is the oldest American self-contained metallic cartridge. It came out in 1857 for Smith & Wesson's First Model revolver. Hard as it might be to believe, at that time the Short was intended more for self defense than for hunting or competition.

I have deep affection for the 22 rimfire. I cut my shooting teeth with this cartridge, and it was all I could afford for varmint shooting during the Depression era. Two of my close friends, twin brothers, Ray and Roy Johns, owned a Hamilton 22. At our local country store, Shorts were four for a penny. By pooling our resources we sometimes could buy a handful. We used them to good advantage on rats and mice in our barns and pigpens. I might add that the Hamilton, with its wood stock and brass-lined barrel, carried

Countless riflemen use 22 rimfires for competitive shooting, but Helen and I like their accuracy and low noise level for squirrel hunting. She's using a Walther KKJ here and I have an Anschutz.

the exorbitant price tag of $2.50. Most country boys in those days earned a Hamilton by selling a dozen or so cans of an all-purpose salve. The little single shot was not exactly a Ruger 77/22 or a Remington 541-T when it came to accuracy, but it was the prized possession of any kid who had one.

The 22 Long has a disputed history. A few cartridge historians claim the 22 Long is a maverick that combines the Long Rifle case with the Short's 29-gr. bullet. Others argue, and I'm now inclined to agree with them though I didn't in years past, that the 22 Long was a black powder cartridge developed fifteen or more years before the Long Rifle cartridge. This more or less puts the shoe on the other foot. In a sense, though, this could still leave the Long as something of a maverick. There is really no need for the 22 Long. It's sort of a high velocity Short, but it doesn't have the accuracy or energy of the Long Rifle, which is the logical choice when moving up. It is possible to put more Longs in a tubular magazine than Long Rifle cartridges, if that is worth considering.

The 22 Long Rifle normally has a 40-gr. bullet (36-38 grains in hollow point versions), instead of a 29-gr. as in the Long and Short. To gain higher velocities, several brands of hyper velocity 22 rimfire fodder use even lighter bullets. Examples are the 32-gr. slug in CCI's Stinger and the 36-gr. bullet in Remington's Viper ammo.

The J. Stevens Arms is credited with developing the Long Rifle cartridge in 1887. It was the 22 Long case carrying 5 grains of black powder and a 40-gr. bullet. For over a century now, the 22 Long Rifle cartridge has been used around the world. Everything from small pests to high level competition is fair challenge for the little cartridge.

For decades, the 22 Long Rifle was king of the varmint cartridges. Not because of its superiority over various other cartridges, but simply because the 22 rimfire rifle was a standard household item, and still is. Countless people who don't hunt keep a 22 rifle for plinking. The 22 Hornet became a serious competitor of the 22 rimfire in the 1930s, but the higher price of this centerfire rifle and its ammo kept the Hornet beyond the financial reach of many dedicated varmint hunters.

The 22 Long Rifle may not be a true hunting cartridge except for squirrel and other small mammals, but it is not a toy. It always disturbs me to hear so-called qualified hunters place the 22 rimfire in that category. It's far from that. It tosses a 40-gr. slug out of the muzzle at well over 1200 fps, and I've killed numerous chucks instantly with head shots at 75 yards. I'm not recommending the 22 rimfire as a long range varmint cartridge, but this should prove beyond a doubt it's not in the toy class.

Tradition is the 22's worst enemy. The old Stevens Maynard Junior Rifle

and the Quackenbush Cartridge Rifle were the farm boy's best friends in the kerosene lamp era. Old ads showed the barefoot farm kid with his Maynard, Crackshot or Quackenbush displaying a rat or some other unwanted pest. Some modern advertisements run along the same line. They show a youngster knocking a tin can off a stump while the father waves his arms in glee over his son's accurate shooting. There's nothing wrong with shooting at tin cans with safe backstops, but I think such advertising is demeaning to a cartridge that qualifies for some types of hunting. It leads many to believe the 22 is a low-powered relic from the past. There happens to be another side. The common 22 is a useful cartridge that has a definite place in a hunter's career. It's far from a powerful load as we tend to define power today, and its ballistics won't compare with even the mild Hornet or 218 Bee, but that doesn't mean it has no place in the gun fraternity except for plinking and indoor competition. If nothing else, it should be recognized as the most suitable cartridge for the beginner.

Many times a father brought his son to my shop and had him unwrap an expensive big game rifle. I've scoped dozens of such powerhouses for boys who were not big enough or mature enough to handle them. The gleam in the father's eye might have been pride, but the youngster would have been far better off with a cartridge that had less recoil and a rifle that weighed less. The fact that we live in an affluent age is not reason enough to start a young hunter with such a rifle. But that's a common mistake today.

Many early rimfire rifles suffered from shoddy design and poor workmanship. Here again, that was a throwback to the days of the dirt cheap rimfire. I never understood the thinking of the persons who designed those outfits. Many of the hundreds of 22 rimfires I worked on were a discredit to their manufacturers. In fairness, keeping the price low might have been a paramount factor in staying competitive. We no longer live in a society where everything is judged by how little it costs. In today's market there is no need to design a 22 for nothing more than a low selling price. Today's hunter does not mind paying a reasonable amount for a rifle if it shows good material and high quality workmanship.

My biggest complaint with the run-of-the-mill 22 rimfire is its trigger. On inexpensive rimfires perhaps it's not economically feasible to install an adjustable trigger, but why go to the expense of producing a high quality bolt action rimfire and then fit it with a non-adjustable trigger? At least a clean-breaking trigger should be factory fitted. Some so-called adjustable triggers offer only a tension spring adjusting screw that will increase or decrease to some extent the weight of pull. This certainly helps, but the trigger usually still has bothersome creep and overtravel.

Overtravel is the backward movement of the trigger after the sear has been released. There should be just enough rearward movement to fire the rifle. Excessive overtravel can cause a slight movement of the rifle before the bullet leaves the barrel. Finely tuned triggers have no perceptible overtravel. On many 22 rimfire outfits, there is no way to eliminate overtravel because part of the trigger's mechanism is used for a bolt stop.

The bolt stop prevents the bolt from being pulled out of the action. To remove the bolt on most big game rifles, a lever or plunger on the side of the action is moved. Only a few 22 rimfire outfits have separate bolt stop release mechanisms. Usually, a part of the trigger assembly protrudes through the bottom of the receiver to stop the bolt. To remove the bolt, the trigger must be pulled back farther than its normal release point to depress the stop below the bottom of the receiver. The bolt can then slide over the stop. However, with this type of bolt stop release, there is no way to eliminate overtravel.

I have drilled and tapped the rear of the trigger guard and installed a screw that could be adjusted and locked so the trigger had only enough rearward movement to fire the rifle. To remove the bolt for cleaning, the nut had to be loosened and the screw backed off. This setup worked but was unsightly and not as efficient as having an overtravel adjustment incorporated into the trigger.

Triggers on some inexpensive rifles consist of white metal or pressed steel parts, plus springs and links that cover perhaps two to four inches on the bottom of the receiver. Sometimes that is necessary as many repeating outfits incorporate the cartridge feeding mechanism into the same housing with the trigger. On a few single shots, the trigger is nothing more than a stamped piece of white metal that includes the sear and bolt stop. A shoulder on the bottom of the bolt engages the stop on the trigger. To remove the bolt, the trigger must be pulled back far enough to disengage the stop. One small pin holds the trigger to the action and a spring fitted into the receiver pushes against a part of the trigger to provide the necessary tension. This simple setup gets the job done, but there is no type of adjustment. Normally, such a trigger has a good bit of free play and is hard to pull. The heavy pull is the most annoying problem. Some I have weighed far exceeded the 5-pound limit (80-ounces) of the trigger scale.

Target and semi-target 22 rimfire rifles have adjustable triggers. Winchester's M52 and Remington's M37, now discontinued, had adjustable triggers. Down the ladder in the semi-target class are some oldies with adjustable triggers such as the Remington M513, Winchester M75 and Mossberg M144. These have all bitten the dust, but rifles such as today's Anschutz, Beeman/Krico, Walther, Kimber, Remington 40XR, Ruger and

Browning offer adjustable triggers or triggers that are factory set for a clean, crisp break with a pull between 3 and 4 pounds. That much pull allows the hunter to feel some pressure against the trigger before the rifle fires. Set or match triggers, when adjusted down too far, aren't advisable for hunting. I used a Beeman/Krico 340 Metallic Silhouette rifle for squirrels during one season. Designed as a competitive outfit, the 340 has a lot of bulk and weight for an all day hunt, but its match-type trigger is superb. It can be adjusted down to a few ounces for silhouette competition, but in the squirrel woods I set it for several pounds.

I am putting a lot of emphasis on the trigger because it largely determines how well we shoot. No matter how good the stock or the machine work on the receiver and barrel, if the trigger is too heavy or rough or inconsistent, the hunter will be always be at a disadvantage. He won't be able to get the rifle's full accuracy potential. This is true with all rifles, but on some types such as levers and slide action outfits, little can be done to improve the trigger. Improvements that can be made on these are usually expensive. For the most part, the rifle isn't worth it. The adjustable trigger fits the format of the bolt action rifle.

A good trigger is not just a lightweight trigger. Reducing the pull is not the total answer. The ultimate trigger is free from creep, has the exact pull desired by the shooter, and has no overtravel. When the index finger engages the trigger, there is no perceptible movement. As the finger tightens, the release should be void of any telltale backward movement after the hammer or firing pin falls. Actually, the trigger should feel "hard" when touched. By applying a steady even pressure, the trigger releases without the shooter being aware of it.

After firing over 6000 rifles I'm

A 22 rimfire will do the job on even tough chucks if the bullet is placed precisely, preferably between the eye and ear, and the range is not too long.

convinced that the trigger is a highly important part of a rifle's firing mechanism, perhaps the most important. Unfortunately, it gets little attention except in high grade rifles. The lack of a good release has kept the 22 rimfire from being paid the respect it deserves.

As common as the 22 rimfire is, it's amazing how many hunters have only a passing acquaintance with it. It's discouraging to learn that some hunters assume the 22 has no real value except for plinking. Despite all the misconceptions about it, the 22 was the forerunner of all the high speed, ear shattering varmint rifles that are in the spotlight today.

The 22 rimfire was the king of varmint rifles for a few decades, mostly due to its availability rather than its power. The 22 Long Rifle is not truly effective on varmints such as chucks and prairie dogs beyond 60 to 75 yards. I've killed occasional chucks with it at longer ranges, but several unpleasant experiences forced me to settle on 75 yards as its maximum effective killing distance. I know some 22 rimfire fans won't agree with that, but there is a humane side to consider. A kill now and then at 100 yards doesn't prove anything in my book.

The advent of the 22 Hornet sounded the death knell for the little rimfire in the varmint realm. The Hornet would have rendered the coup de grace immediately if the national economic picture had been brighter in the early 1930s. The Hornet required a more costly rifle, and this put it beyond the financial reach of most hunters. Also, there was a significant difference in the price of ammunition. A Hornet cartridge cost three or four cents, compared to twenty cents for a box of fifty 22 rimfires. During the Great Depression, the choice was not hard to make.

I shot my first chuck soon after President Franklin D. Roosevelt made his famous "nothing to fear but fear itself" speech. I used a Winchester Model 60 single shot that belonged to a friend. It never occurred to me that I was undergunned. During the ensuing years, I shot countless chucks, crows and squirrels with the 22 rimfire. As far as I am concerned, it is a genuine hunting cartridge.

I am not extolling the virtues of the 22 rimfire because of my long association with the tiny cartridge, but because I know it has plenty to offer in certain kinds of shooting. That includes target competition, some types of hunting, and just plinking for the heck of it. It is definitely not a long range varmint cartridge, but it is the top squirrel cartridge.

Velocity range for the 22 Long Rifle cartridge runs from around 1135 fps at the muzzle for target ammo to as high as 1640 fps for CCI's 32-gr. Stinger bullet. That's less than 300 fps below the 22 Winchester Magnum Rimfire's 40-gr. bullet. This may not be as impressive as the velocities from 224

centerfire varmint cartridges, but it's more than adequate for 50-yard shots in the squirrel woods.

Some believe the 22's velocity is so low that the bullet can be followed in flight by the naked eye. That's not true. An exception might be the 22 CB Cap cartridge which has a muzzle velocity of around 700 fps. However, a tiny bullet is difficult to see even at that slow speed. I have caught a glimpse of a rimfire bullet from target ammo several times, but that doesn't prove anything. A chance sighting is due more to certain light conditions than the comparatively low velocity of the bullet.

When I was a young shooter, it was a common belief that accuracy was the sole product of the rifle. The more expensive the rifle, the more accurate it was. That isn't necessarily true, but I heard it often in hot stove league discussions. Most aspects of external ballistics were still mysteries during that period. Little thought was given to the bullet. With this misconception firmly imbedded in the local hunting fraternity, high speed ammo came into vogue. I always bought Super-X hollow points for squirrel hunting. I was convinced their extra velocity was the answer. I'm ashamed to admit I didn't test ammo for accuracy back then, and I didn't know anyone who did. It was assumed the bullet would go precisely where the hunter was aiming. When a miss occurred, the blame was put on poor shooting, not on the rifle or ammo. We didn't realize how important it was to mate rimfire ammo with the rifle being used. In fact, we weren't aware of any 22 rimfire eccentricities.

The 22 rimfire is eccentric — you can chisel that statement in stone. I eventually learned that from shooting thousands of rounds in tests. The competitive shooter finds and sticks with the brand of ammo that works best in his particular rifle, and that should tell us something. For example, a friend who is a competition shooter has a Winchester 52 International Match rifle and a Savage/Anschutz Model 1413 Super Match 54 Target outfit. He has to use different brands of target fodder in each rifle. That's not unusual. Even super accurate competitive 22 rimfires are a little on the eccentric side. If one kind of ammo doesn't group well in your rifle, try some others before relegating it to the ranks of the unwanted. Chances are something will work fine.

After testing most brands of high speed and target ammo, I am convinced the target grade has a distinct edge in accuracy. More importantly from the hunter's viewpoint, in 50-yard range tests, target ammo gave tighter groups with every type and model of rifle tested. That's quite a testimony.

I have used target ammo in the squirrel woods for years, and never found its lower velocities lacking in killing power. Some squirrel hunters think just the opposite, but I base my convictions on experience. With the added degree

of accuracy offered by target ammo, the hunter can be more precise; proper bullet placement is more effective than sheer power.

If muzzle velocity is the main reason for not using target ammo which generates velocities around 1100 fps, a look at the Long Rifle cartridge's ballistics might change some attitudes. Other than two or three brands of ultra high velocity loads that produce muzzle velocities in the 1500 fps area, the conventional Long Rifle bullet seldom leaves the muzzle much beyond 1250 fps. But this is only 250 fps less than the hyper velocity loads, which is of little significance on a 50-yard shot. This shows that target ammo is more than adequate for long range squirrel shooting. Another feature I've appreciated with target ammo over the years is the low noise level, but accuracy is still the paramount factor from my point of view. Let me give an example.

During the late 1960s, I installed a Remington 513T adjustable trigger on Milt Anderson's 521T (the M513T Matchmaker was a target rifle with an adjustable trigger, the M521T a combination hunting and target rifle). This setup worked nicely, but required some minor changes and adjustments to get the trigger down to a clean, crisp pull of three pounds. My efforts appeared to be in vain. The first range tests were fired with several brands of high speed ammo he had sent with the rifle. The 5-shot groups were poor — well over 1¼ inches. He suggested I try other brands of high speed fodder. Power was still dominating the thinking of squirrel hunters.

After numerous brands had been tested without finding any that would give consistent groups of an inch or less, I switched to target ammo. My spirits soared when the first 5-shot group on the 50-yard target fell well below the inch mark. But I didn't allow my emotions to get out of hand as I knew that might be one of those rare groups that happen once in awhile with every rifle. As it turned out, I had nothing to worry about. Winchester's EZXS seldom spread beyond ¾ inch for me, and Helen's tests put the icing on the cake with three 5-shot groups that ranged from ¼ to ⅜ inch. Milt had been all set to fire high speed fodder, as he had always done, but our 50-yard tests changed his way of thinking.

It's probably obvious that I haven't mentioned the 22 Winchester Magnum Rimfire. It's not that I feel it shouldn't be used for squirrel hunting or general rimfire use, but I don't thinks its extra power is needed here. Its additional 300 fps with the 40-gr. slug (Federal offers a 50-gr. WMR bullet with 1650 fps muzzle velocity) over CCI's 32-gr. Stinger hollow point doesn't impress me greatly. Remington's 22 Long Rifle Yellow Jacket cartridge hits 1500 fps with the 33-gr. truncated cone hollow point bullet.

I'm comparing the WMR with the top velocity 22 rimfire cartridges

because the argument for the 22 WMR is its higher speed. These relatively new super-fast standard rimfire cartridges use lighter bullets to help gain extra velocity. For squirrel shooting, if speed is the first consideration, the lower bullet weights of the hyper velocity cartridges are still adequate. However, I have to point out that the super speed rimfires I've tested didn't meet my accuracy requirements for the squirrel woods. Other experienced hunters have told me of results similar to mine.

I'm certainly not against the WMR, but must admit I have not given it much coverage in past squirrel articles. This fact brought a letter from a man in Ireland who had read a piece I'd done for Stoeger's *Shooter's Bible* some years ago. He stated that due to the problems in his country only 22s were allowed to the general public. He was disappointed that in an article on 22 rimfires, I hadn't even mentioned the 22 WMR. He felt American hunters considered the WMR to be insignificant. He wondered, however, how insignificant we would think the tiny rimfire was if we were confined to that one caliber alone. He had a genuine point. But I hadn't omitted the WMR for personal reasons or because I felt it couldn't be used for squirrel and short range varmint shooting. The WMR just doesn't fit into my thinking as a squirrel cartridge.

Range tests have shown me the WMR is not as accurate as conventional 22 target ammo. The extra velocity of the WMR could add yardage if it gave the necessary accuracy, but squirrel shooting, unlike varmint hunting, isn't a long range sport. I have a self-imposed 50-yard limit in squirrel timber, but for a trained rifleman Long Rifle can often do the job on a 60-yard shot. It's highly unlikely a squirrel hunter would be faced with many shots beyond that range. With less accuracy and more expense for ammo, there doesn't seem to be much favoring the WMR as a squirrel cartridge.

Since the days of the Flobert there has been a concerted effort to improve the rimfire cartridge. I don't intend to give a historical background, but from the BB Cap through the Short, Long and Long Rifle, the quest for power was the goal of some cartridge designers. The Extra Long was an attempt to upgrade the 22 rimfire this way. The 22 Extra Long showed up around 1880. It used a 40-gr. bullet and 6 grains of black powder, and it had a slight velocity edge over the Long Rifle ammo of that era. But it wasn't as accurate. That was not the only reason the Extra Long failed to capture a following. Due to its case length, it wouldn't chamber in rifles intended for conventional 22 cartridges. This meant buying a separate rifle to use it. That wasn't necessarily bad. Since the Extra Long was the same diameter as regular 22 rimfires, Shorts, Longs, and Long Rifles could be fired in an Extra Long Rifle.

Around 1890, Winchester developed the Winchester Rimfire (WRF) for its 1890 pump rifle. Remington's version differed only in the shape of the bullet. Winchester's had a flat-nosed bullet designed specifically for its tubular magazine pump rifles, while Remington's 22 Special had a round nose bullet. The two were otherwise identical. The WRF did offer the rimfire fan a better killing cartridge as it had a muzzle velocity above 1400 fps. But it was never as accurate as the Long Rifle cartridge. The WRF with its larger case diameter won't chamber in regular 22 rimfires. Conventional rimfire cartridges should not be used in the WRF as the cases will often split when fired.

The WRF was the precursor of the Winchester 22 Magnum Rimfire. The WMR is a longer, more powerful version of the WRF. The cases are not interchangeable although the WRF round can be used in WMR rifles. The Winchester Magnum Rimfire is too powerful for actions of the WRF rifle, and it's advisable not to rechamber the older WRF rifles for the WMR cartridge.

To my mind, the WMR cartridge has more to offer in a handgun than in a rifle. It gives good velocity readings even from short barrels, so does add extra speed and power for the handgunner. But it has little to entice the rifle shooter who can choose one of the smaller centerfire cartridges such as the 22 Hornet, 218 Bee, or 222 Remington.

During the summer of 1973, I fired hundreds of rounds on the range and in the chuck pastures with the WMR. Accuracy on the 100-yard range was passable but not spectacular. For woodchucks, 125 yards was about the limit for clean kills, and even at that short range it required exact bullet placement. Top kinetic energy at the muzzle with the WMR's 40-gr. HP bullet at 2000 fps is only 355 foot pounds. Out at 100 yards, velocity has

Two of my favorite squirrel outfits, the K22 Kleinguenther at left with 8x Leupold and Ruger's M77/22 topped with a Weaver KT6. Both will group well under an inch at 50 yards, even with hollowpoint ammo.

dropped to 1400 fps and energy output is 175 foot pounds. Not quite what I would term efficient killing power on creatures tough as the woodchuck if placement isn't good.

It can be pointed out that both 100-yard figures of the 22 WMR exceed the Long Rifle's best efforts at the muzzle. The Long Rifle high velocity hollow point load has a muzzle velocity of 1280 fps and generates 131 foot pounds of energy. At 100 yards, these figures have fallen to 1010 fps and 82 fp. So the WMR does have a considerable power advantage over the 22 Long Rifle.

This is true if figures are all that is being considered. My opposition to the 22 WMR is not that it isn't more powerful than the Long Rifle, but that it just doesn't make a substantial contribution to any phase of hunting or shooting. While it offers approximately a 40-yard advantage over the Long Rifle for small varmints, it doesn't come close the 22 Hornet or 218 Bee as a varmint cartridge. In fact, the 22 WMR's 2000 fps muzzle velocity is only a step ahead of several hyper velocity 22 rimfire cartridges now available. I shot quite a few chucks at from 90 to 135 yards with the WMR, but it just didn't have enough energy to make a clean kill unless the bullet struck the brain, neck or spine, and there was little bullet damage beyond the 100-yard mark. After a summer of hunting and testing the WMR and the similar Remington 5mm, I reached the conclusion that neither fell into the long range varmint-hunting category.

The Remington 5mm Rimfire Magnum is a similar cartridge but is no longer available. It was introduced in 1970, a small bottlenecked case holding a bullet of unusual diameter, 20 caliber. Its 38-gr. bullet had a muzzle velocity of 2100 fps. When the 5mm Magnum was introduced, Winchester's WMR cartridge was generating a fair amount of interest. Remington must have seen a future for their new cartridge as they brought out two bolt action rifles for it, the Model 591 with a detachable clip and the 592 with a tubular magazine.

I always had the feeling that the best niche for both the 5mm Remington and the 22 WMR was as wild turkey loads. A friend, Glenn Hoy, has had excellent success with the 5mm on turkeys — "just bang and plop" is how he describes his results on several dozen of these big birds. Of course, he hits them right. And of course both of these loads make acceptable short range varmint choices for the man who doesn't want to get into reloading.

I have no idea why Remington discontinued the 5mm Magnum, but guess it wasn't making any waves in the marketplace. Like the 22 WMR, it has only limited applicability, and the ammo's extra cost, more than double the price of Long Rifles, is a factor worth considering.

Now that the conventional Long Rifle category has been infiltrated by

hyper-velocity cartridges such as the CCI Stinger and the Remington Yellow Jacket, the 22 WMR could be engaged in a life and death battle. I'm not hoping that comes to pass. In fact, I was saddened to see the 5mm Magnum Remington bite the dust. While neither of these magnum rimfires appealed to me as hunting cartridges, I am only one voice; I am not so self-opinionated as to attempt to persuade the entire shooting fraternity to accept my views.

To me, a good rifle is an accurate rifle. I am not overly concerned about looks, type of stock wood or barrel length if a rifle meets the accuracy standards for the type of hunting it will be used for. Make a mental note of that sentence, because accuracy requirements are not the same for all types of hunting rifles. In the squirrel-hunting category, I feel the Long Rifle rimfire outfit should be capable of consistently putting five shots in an inch or less at 50 yards from the benchrest. While that might seem easy to accomplish, many rifles and brands of ammunition will not do it. And not every hunter is able to shoot this well, no matter how accurate his rifle is. It's obvious that practice is the answer. Until the shooter learns how to shoot consistent groups at 50 yards, the accuracy potential of his rifle will remain unknown.

Many squirrel hunters smile at the idea of carrying semi-target rifles such as the Anschutz Model 1403D or Beeman/Krico 340 Metallic Silhouette for the insignificant tree climber. These rifles are expensive, fairly heavy when scoped, and cumbersome, and such factors aren't enticements to the squirrel hunter. But there's more. In the semi-target rifle, accuracy is the main selling point. The semi-target rifle may be heavier and designed for competition, but it is far more accurate than most hunting 22s. That's the major difference, and that's a factor that shouldn't be overlooked if you're interested in having the ultimate squirrel rifle. Hunting with a rifle that has pinpoint accuracy adds a new dimension to squirrel hunting.

I don't want to give the impression that only target or semi-target rifles give acceptable accuracy on the 50-yard range. They are more likely to have this potential, but I have cut inch or less groups with all types of actions. That's why I advocate seriously testing any rimfire before condemning it. Normally, the bolt action outfit with its stronger lockup has the edge in accuracy. This holds true with all calibers and types of rifles. On the other hand, many hunters prefer a pump or lever, and I don't mean just for big game but for squirrel hunting as well. There's an interesting reason for this.

Once I heard a hunter say, "Shucks, it wouldn't be deer hunting for me if I didn't have a lever action." That remark has stuck with me, and it pretty well explains the strong feelings a hunter can have for the action he uses. When I was a youngster, a veteran hunter from a nearby village refused to use any

rifle except a battered Model 141 Remington slide action chambered for the 35 Remington cartridge. He was adept with the pump action and had faith in that cartridge. It paid off for him; his 35 Remington pump dropped over 30 bucks.

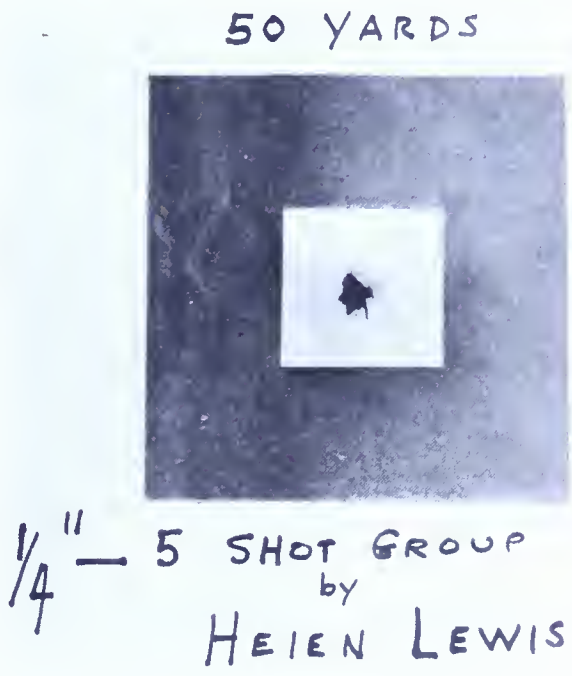
Homo sapiens is like that in practically every aspect of life. I like one type of vehicle, my neighbor likes something different, and so it goes. The same holds true in the hunting game. One type of rifle, no matter how much it has to offer, will not satisfy every hunter. Actually, that is the way it should be. To enjoy hunting to the fullest, the hunter must satisfy his psychological side.

While testing CCI's Green Tag competition ammo in high quality bolt action 22 rimfire rifles such as the Ruger 77/22R, Remington 541-T, Kimber 82, Krico 340 MS, and the discontinued Savage/Anschutz Model 64, I switched to a Marlin Golden 39A lever action just to see how it would perform against the more expensive bolt actions. To be honest, I wasn't prepared for the 50-yard results I got. Three 5-shot groups printed in the 1 1/4-inch category, several stayed on the inch bullseye, and one group dropped to 5/8 inch. This was literally on par with the fine bolt actions and a lot better than most over-the-counter bolt action 22s will do. I gained extra respect for the Marlin 39A after that episode.

The groups I have fired with slide action 22s almost never matched the ones fired from levers and bolt actions. That doesn't mean I am trying to rule the pump out as a squirrel rifle. I'm basing my case strictly on the results obtained on the 50-yard range. I'm convinced that accuracy suffers from the pump's weaker locking system. I have probably opened the door for some criticism, but I'm only revealing what dozens of range tests have shown me. Facts are facts, and despite all the nostalgia the rimfire slide action has, and it certainly has the edge in speed and ease of operation, I'm convinced it's not as accurate as the two other types mentioned. My tests also indicated the 22 pumps are more accurate than rimfire autoloaders.

Autoloaders are not currently legal for hunting in Pennsylvania. Down the road a few years, that could change. I don't have a lot of experience with the autoloader, but I have tested Ruger's 10/22 and Weatherby's Mark XXII autoloaders. Occasionally, a group would cut around the inch mark, but most measured 1 1/4 to 1 3/4 inches. During one test with the Ruger, I fired a 10-shot group in nine seconds that measured 1 7/8 inches center to center.

I fired each of these autoloaders several hundred shots without experiencing any loading or extraction problems. Also, their actions functioned just as well with target ammo as with high speed fodder. Weatherby's Mark XXII has a single shot selector. When so set, the bolt stays open after each shot and the selector must be pushed forward to free it;



This is the kind of accuracy some 22 rifles and ammo are capable of, off the bench. Obviously, this outfit is deadly on squirrels.

that's a nice safety feature, I think.

If it seems I have come down a little hard on the autoloaders, I want to say it's not my desire to condemn them; it's just that their actions are designed for self-loading with a recoil type bolt. As there are no locking lugs on the bolt, there can't be as tight and consistent a lockup as on a bolt action. This makes it difficult for the autoloader to deliver the same degree of accuracy as other actions. Except for that drawback, the autoloader is as practical as the rest of the rimfire actions — bolt, pump or lever.

As a final comment, I learned from years of rimfire range testing that, overall, the bolt action outfit has an edge in accuracy. Maybe it makes better sense to say the bolt action rifle is more consistent — tighter groups with fewer fliers.

Although the 5-shot 1-inch group at 50-yards is a fair standard to judge the squirrel rifle by, I would not quit hunting if my only rifle shot 1½-inch groups there. The average shot at squirrels is between 25 and 35 yards. A 50-yard 1½-inch group is a ¾-inch group at 25 yards and probably no more than an inch spread at 35 yards. So there's no reason in the world that a rifle which consistently fires 1½-inch groups from the 50-yard benchrest can't be used for squirrel hunting. For one thing, the 1½-inch group may not be as bad as it looks, but I'll explain that when I get to the shooting section.

Accuracy from the benchrest is one thing; shooting in the squirrel woods is vastly different. From the comfort of two sandbags on a bench, the shooter has everything in his favor — steadiness, level shooting, and a fixed distance. It's not quite like that in the tall timber where the wily gray squirrel lives. There, shooting rests are improvised, angles can be severe, and it's anybody's guess how far the target is from the muzzle. What alternatives does the hunter have?

When shots stretch to 40 yards or more, I aim for the center of the chest, not the head. That gives some latitude for my unsteadiness and the unknown distance. I would like to explain why I rarely take head shots. I'm aware that folklore tells us the rifle-toting squirrel hunters of yesteryear made only head shots. After a half-century of matching my limited shooting skills against the wily tree climbers, I don't put much stock in folklore. Such stories have a nostalgic ring, but that doesn't mean they are true. My opposition to head shots has nothing to do with the skills of the hunter or the accuracy of his rifle; it's based entirely on the humane aspect. Every precaution should be taken to keep from wounding a squirrel, and there's more chance of wounding by head shooting than by aiming at a large area of the body. Let me explain. From the side, a squirrel's head is a fairly large target at woods ranges if a shooter has a good outfit and a rest. However, a large percentage of the head's total area, particularly from the side, is not vital. A bullet placed between the eye and the ear is normally instantly fatal; however, if the rifle is a bit out of zero or the shooter goofs a trifle, the bullet may hit the upper or lower jaw, seriously wounding the animal and making it impossible for him to eat, but not killing it. That's something no hunter wants to do, for it means a lingering, painful death for an animal that's going to go to waste. So I feel it's wiser to aim for the neck, or ribcage. This certainly cuts down the chances of wounding. I admit the neck is my favorite target, but I don't hesitate one second to aim for the ribcage. I have total shooting satisfaction when I hit my aiming point.

Since this is a hunter's book, I have correlated the 22 rimfire with squirrel hunting. It's at its best in the squirrel woods, but I'm also aware the 22 rimfire cartridge has many other uses. It's still the best training cartridge for the new hunter. It's the most practical and economical for indoor competitive shooting. It is also right at home as the family fun cartridge for just plinking. In the handgun, it's unbeatable for the trapper and raccoon hunter. What the 22 rimfire cartridge is used for is a matter for each person to decide. I like the challenges faced by the 22 rimfire squirrel hunter.

Lastly, I don't want to give the impression that every bolt action rifle is accurate or meets all the qualifications for squirrel hunting. Nor is every bolt action automatically superior to every lever, pump or autoloader. That's not the case. A close look at a few makes and models of rimfires on the market today might bring to light some interesting facts.

Comments on Some Rimfires

I OBVIOUSLY WON'T be able to go into detail on every make and model of 22 rimfire. The basic information is readily available in gun catalogs. What I want to dc is touch on certain models and their features or highlights which have interested me personally and might be helpful to the prospective buyer. Most data here will pertain to rifles now on the market, but I will also include comments on several discontinued models to aid the hunter or shooter who is looking for a fine used outfit.

One rimfire that has impressed me more than usual is the bolt action Ruger 77/22. It can't be classed as an inexpensive outfit, but it's far from the top of the ladder in the price column. One of its interesting features is a 10-shot rotary magazine that fits flush into the forearm. The magazine throat, retaining guides, and ramps that guide the shell into the chamber are solid steel. They won't bend or warp.

The bolt is unusual, too. Ruger says it is built to military standards of quality, but has been modified to operate with the conventional 22 rimfire cartridge. Its locking lugs are on the middle section of the bolt, and the front is non-rotating, but the rear portion rotates and cams like its big brother, the M77 centerfire rifles.

The M77/22 has a positive lockup with two large lugs on the rotating part of the bolt. The bolt functions within Ruger's typical heavy Mauser-type receiver which also has integral scope bases for the one-inch scope rings that come with the Model 77/22R (plain barrel without open sights). The bases are part of the receiver; they are not attached with screws as on conventional mounts. A simplified bolt stop fits flush with the left side of the receiver and permits the bolt to be removed merely by pressing down lightly with the thumbnail.

The M77/22 has a 3-position safety. With the safety in its middle, or

"safe," position, the rifle will not fire but the bolt can be operated and the chamber emptied. When the safety is in its rearward, or "lock," position, a dead bolt is cammed forward, locking the bolt handle down. The action is locked and the bolt handle cannot be raised. This feature ensures that the rifle can be carried in dense cover or wooded areas without danger of the bolt being opened if the handle catches on a limb or vine.

I'm always concerned about triggers, and I was disappointed to find the 77/22's is non-adjustable. My fears were somewhat allayed by the fast locktime of Ruger's setup. This means a fast release. The trigger mechanism includes a single coil spring for both sear recovery and trigger return. Locktime is calculated at 2.7 milliseconds, which is comparable to that of the most sophisticated target rifle. The trigger is set at the factory for a crisp, medium-weight pull in the 3- to 4-pound class. Several 77/22 triggers that I have weighed released at about the 60-ounce mark.

Normally, a non-adjustable trigger won't release in a consistent manner. Many have significant variations in the weight of pull, and I have found this to be especially true in rimfire trigger setups. This doesn't hold true with the 77/22 Ruger. On my Model 77/22, five consecutive releases gave readings of 58 to 63 ounces which translates into a 3 3/4-pound trigger. It also shows the Ruger has a consistent pull weight, which is important to accuracy. A rimfire rifle that has an erratic trigger makes top accuracy almost impossible.

I want to inject here a word of caution about snapping the trigger on an empty 22. The firing pin may strike the rear face of the barrel which normally supports the rim of the cartridge case. This can damage the firing pin. I recall one incident when a

Veteran squirrel hunter Bill Nichols says the Kimber 82 with Weaver T6 scope is as good a rig as anyone can carry into the woods.

hunter snapped his rifle on an empty chamber and unknowingly broke a chip off the firing pin. This left a sharp point on the end of the pin and, when he later fired the rifle, the firing pin pierced the cartridge rim and ruptured the shell case. Rimfires should not be snapped on empty chambers.

When weighing 22 rimfire bolt action triggers, I insert an empty rimfire case in the chamber to act as a buffer to prevent any damage to the firing pin or the rear of the barrel. This gives a soft striking surface for the firing pin to strike, though the empty case has to be replaced often. Each time I snap the trigger, I operate the bolt handle just enough to cock the firing pin without removing the empty case. Some actions have to be worked fully to cock an internal hammer. This ejects the empty. If extensive testing is being done on a trigger, the firing pin can be removed, but this is time consuming and unnecessary in most cases. I found it easier to insert an empty case as often as needed.

The M77/22 employs the dual-screw attachment system used with great success in Ruger's autoloading Model 10-22. Two longitudinal screws, working through a heavy V-block barrel retainer, pull the barrel tightly into the receiver, rigidly locking these two parts together. The barrel is free-floating and does not contact the stock. This contributes materially to the 77/22's accuracy. The stock is American walnut, and all metal parts are polished and handsomely finished in a deep, lustrous blue with a matte, non-glare surface on the top of the receiver. The M77/22 is unquestionably a high quality rimfire.

The old saying that the proof of the pudding is in the eating applies to a rifle's worth. Accuracy is the important thing and the M77/22 proved itself at the 50-yard benchrest. I have lost the actual test records, but when a rifle keeps cutting less than inch groups, it's not easily forgotten. That's precisely what the 77/22 did, with several brands of target ammo. Groups did spread somewhat when I fired two or three brands of extra high speed fodder. The largest was around 1½ inches. Best results came with Eley Red Box and CCI's Green Tag ammo, although I must admit that Winchester's Super Match and Remington's 22 Long Rifle Target cut excellent groups. Winchester's T-22 standard velocity and Federal's lot 711 low velocity ammo gave squirrel-shooting results.

There's an interesting story on my Ruger 77/22 that fits right into the scheme of things here. It also shows the compatability of my marriage. On the first afternoon of Pennsylvania's early squirrel season after I got the Ruger, Helen was carrying a very attractive clip-fed import, and I had the 77/22, topped with a Weaver KT6 scope. The import had done quite well on the 50-yard range for me, and, just before going hunting, Helen fired a tight

group with CCI's Green Tag. But all that seems well doesn't always end well, as I was about to learn.

We had gone a short distance into a favorite patch of squirrel woods, then headed in different directions. I hadn't traveled more than seventy-five feet when Helen fired. Naturally, I turned around to see what she was shooting at. Instead of giving the high sign that her shot had scored, she was feverishly working with the action. I could see she had a jamming problem.

"Take this thing and keep it," she said the instant I arrived at her side. "It's jammed, and I can't get a new round in the chamber."

"Did you get the squirrel?"

"What a dumb question. If I had, I'd be picking it up instead of trying to load the gun. It jumped just as I fired and scooted into a hole. It'll be back, but I don't want this outfit when it appears."

When I handed her the 77/22, she examined it while I solved the problem with the import. Just as I fed a fresh round into the chamber, Helen whispered that the gray was out again. She rested the back of her left hand against a tree and fired. The squirrel had made a fatal mistake by not staying in its den.

"Why wasn't I carrying this rifle to begin with?" she asked.

"You opted for the high gloss, fancy grain stock and the 5-shot clip instead of the plainer Ruger with its 10-shot clip. That's what you wanted."

"Surely you must be mistaken," she said with a grin. "I've never liked a glossy stock, and a 5-shot clip is only half as good as a 10-shot."

With that, she departed — taking the Ruger with her. I hoped the scales of justice would change her thinking, but she tilted the beam in her direction by dropping four more grays with consecutive shots that evening. Such is life. To make a long story short, my association with that particular 77/22 ended right there, and I spent the rest of the season (and every season since) using other rifles. Actually, there was nothing wrong with the import; the jam was just one of those things that happens now and then when we get excited.

When Remington discontinued their Model 541-S in the early 1980s, it was a real blow to rimfire fans who were interested in owning a high quality outfit. The 541-S qualified as a great rifle; it had good looks and a high degree of accuracy. It appeared that a top rimfire outfit had gone down the tube. But there is good news for this sleek outfit. Remington reintroduced it in 1986 as the M541-T.

I haven't yet tested the new 541-T, but I have fired hundreds of rounds through an earlier 541-S Custom Sporter, and I assume there have been no major internal changes. Here again, the 541-T doesn't fall into the inexpensive class, but it has the looks and feel that will satisfy the most

discriminating shooter. On its American walnut stock, there is rich, positive-cut checkering, a distinctive buttplate, grip cap and fore-end tip.

The trigger setup on the 541-S is adjustable for creep, weight of pull and overtravel. A feature that caught my eye is the bolt stop. It is incorporated into the safety which is mounted on the right side and could be classified as a rocker or push/pull type. It has a definite feel to it. To remove the bolt requires pushing the safety well beyond its normal forward release position. A lever extending from the safety then pulls down on the bolt stop pin which protrudes through the bottom of the receiver into a slot in the bottom of the bolt. Pulling down on the pin allows the bolt to be removed.

The 541-S locks up with six lugs on the center of the bolt that cam into recesses in the receiver. That may be overdoing it to some extent, but it does guarantee a tight lockup. Many 22 rimfire bolt action rifles use the bolt handle boss (the square section at the root of the bolt) to lock up against the receiver. So far as strength goes, that is probably adequate, but a bolt handle wears and can become loose. That could lead to a headspace

Somehow, my black phase gray looks a mite puny alongside of the big fox squirrel Russ Whittaker bagged. Russ was hunting with a 77/22 Ruger and Weaver KT6, while I carried a Marlin 39A with 2-8x Bushnell.

problem and cause misfires or ruptured cases. This problem should be corrected immediately by a competent gunsmith.

As with all Remington bolt action rifles, accuracy is an inherent part of the design. With a crisp trigger release and rear locking system comparable to Remington's finest target rifles, the 541-T will perform to a high degree on the range or in the squirrel woods. But no rifle is perfect. My complaint against the 541 Remington rimfire is the way its detachable magazine protrudes. It doesn't stick out of the stock far, but even a little is too much for me. This is a jarring note on a beautiful rifle.

Kimber's Model 82 bolt action is a relative newcomer, introduced around 1980. Some claim the Model 82 was supposed to fill the void left when Winchester discontinued the Model 52 Sporter in 1958. I don't know if that's true or not. Replacing the 52 would be a big job for any rifle. Maybe the Kimber has done it. The model 82 qualifies as a superb piece of workmanship.

The Classic Model 82 I tested is not what could be called a glamorous outfit. It's impressive in a quiet way. The 82 has clean lines and is extremely functional. It lacks the gaudy spacers and gewgaws found on so many of today's rifles. It's restrained but it catches the eye, demanding closer examination. It just doesn't need adornments; they would only detract from it. This Kimber is a classic bolt action 22.

A short rundown of the specs show the Model 82 has a 22-inch, 6-groove, 1 in 16-inch twist barrel. The receiver is round and might seem a bit oversize for a rimfire. I was told this was done to accommodate the bolt which has double front locking lugs and double extractors. A positive safety locks both sear and trigger, but the bolt can be opened with the safety engaged. Another feature I appreciate is the flush-mounted detachable magazine. It has a positive release that saves fingernails and cracked fingers on cold mornings. This makes sense to me. The floorplate and trigger guard are made from heavy metal and are cleanly inletted into the stock.

The Kimber's stock is solid walnut carrying a dull oil finish. The Classic stock is claro walnut with a straight comb featuring 18 line-per-inch, hand-cut borderless checkering. A steel grip cap and steel buttplate are nicely fitted. It's worth pointing out that the Kimber's barrel is screwed into the receiver, which definitely adds strength. The safety is a silent rocker type, and the 82's trigger is fully adjustable. My only complaint about this excellent rifle was Kimber's failure to drill and tap the receiver for scope mounting. They opted for a grooved receiver, which I think detracts from the appearance of any action, though it makes scope installation easy. Also, it more or less forces the buyer to stick with special Kimber mounts which are

not included in the retail price. Other than that personal complaint, the Kimber 82 is truly a fine hunting rifle, and its 50-yard range results proved it does indeed live up to its reputation as a genuine thoroughbred.

Another bolt action which worked to perfection on the range and in the woods is the Beeman/Krico 340 MS. Many avid squirrel hunters will wonder why I'd choose a rifle that is primarily designed for competition, as its bull barrel and massive competition stock would seem to disqualify it in the woods. But there's more. The 340 has Krico's Super Match trigger. This sophisticated design has two sear engagement adjustments which give it an incredibly smooth release. In fact, it's almost imperceptible when set on the low side. For competitive shooting, the Super Match trigger can be brought down to a few ounces. I adjusted my 340's trigger so I could feel it before it released. It is probably the best trigger I have ever used in the squirrel woods.

The 340 gave less than half-inch groups at 50 yards. (Beeman/Krico claims the 340 MS will cut half-inch groups at 100 yards, but I have a feeling these results were obtained in a tunnel.) The best I could do at 100 yards was a 5-shot group that fell just below an inch.

I have the same complaint about the Krico 340 as I had about the Kimber 82 — the grooved receiver. After drilling and tapping countless actions, I have never understood the thinking behind the grooved receiver on top quality rifles. It baffles me to see what great advantage it is supposed to have over one that is drilled and tapped for conventional scope bases. I admit it may, in a few cases, allow more fore and aft movement of the scope rings for eye relief adjustment. Once I was informed it was due to the fact that drilling weakens the receiver. That's hogwash. There's far more metal removed in cutting two long grooves on the upper part of the receiver than would be removed in drilling four small holes. I know for a fact after installing many hundreds of scopes that mount rings held in straight grooves are not as secure as rings mounted on bases that are either an integral part of the receiver or are secured with screws.

In the Weaver setup, for instance, the rings have crossbolts or axles that fit into slots in the bases. When the rings are tightened the crossbolts prevent the scope from moving forward even from the recoil of the largest magnum cartridges. There are other reliable scope mounting systems which I will get involved with later. The clamp-on grooved receiver mount is certainly strong enough for the light recoil of the 22 rimfire, but the gunsmith in me says it's not the best system. To each his own, I guess.

The name Anschutz on 22 rimfires means high quality material, unsurpassed workmanship and accuracy. From the full-blown competitive 1413 Model International Match Rifle to the autoloading Model 525, there is

Helen has got great accuracy out of her 541S Remington on the bench, and finds it does just as well in the high hickories.

evidence of superior workmanship. I used an early Model 64 single shot (a new Model 64MS is now available for silhouette shooters) for squirrel hunting for four years. Topped with a 6 Unertl one inch target scope, the 64 is close to the ultimate for the high tree climbers. Although I have used dozens of outfits for such hunting, some of my best moments in the squirrel woods were with the Savage/Anschutz Model 64. It is remarkably accurate regardless of the elements.

It would be grossly unfair to fail to mention the impact O. F. Mossberg & Sons had on the 22 rimfire's development. Mossberg was the leader for years in rimfires that were functional and yet within the financial reach of everyone. I know that for a fact. I used my brother Dan's Model 46 Mossberg with a side-mounted Mossberg scope for squirrel hunting before the outbreak of World War II.

A small bolt action 22 single shot which recently came on the market has a common name that probably won't ring a bell with many rimfire fans. The rifle is intended for kids and is called the "Chipmunk." The name suggests it's cute and it's small, and that's true. It's a genuine rifle, even though it's only 30 inches long and weighs a mere 2½ pounds. Barrel length is a trifle over 16 inches and length of pull 11½ inches. The stock is hand-rubbed walnut with a Monte Carlo comb. It reminds me of a scaled-down Mauser. The firing mechanism has a manual cocking knob, and the rebounding firing

pin is automatically blocked to prevent an accidental discharge if the rifle is dropped. The Chipmunk is drilled and tapped for a special mount base that accepts standard tip-off rings, and the bolt handle is shaped to clear a scope.

The Chipmunk is now also available for the 22 WMR. My 50-yard range tests gave groups running about 1 1/2 inches. The Chipmunk is not for everyone, but it could be an ideal starter for young boys or girls. It could also be right at home in the backpack or on the trapline. It's a well built little rifle.

Another fine example of workmanship is an old favorite, Marlin's Golden 39A. A lever action rifle of genuine beauty, it has an aura of strength and durability. Just looking at one brings back memories for me as I used a Marlin 39 on the trapline as a kid. The Golden 39A lever action 22 is said to be the oldest shoulder gun still being manufactured. The only older gun design still in production, at least in this country, is Colt's 1873 Single Action Army revolver. The forerunner of the Model 39 saw the light of day in 1891, and the new Golden 39A still carries much of that version's original design.

The Golden 39A has a solid top receiver that makes scope mounting easy by just attaching the base that comes with the rifle. If iron sights are preferred, Marlin sandblasted the top of the flat receiver to prevent glare. The 39A boasts solid steel forgings. Its heat treated breechbolt, hammer, trigger, lever and two-piece receiver are machined from steel forgings. There are no shortcuts in its manufacture. Marlin claims the Golden 39A is still the standard by which all other rimfire lever actions are judged. That's a broad statement, but this Marlin has a prestigious past and it has well stood the test of time. It has a one-step takedown design that is unsurpassed for simplicity. It can be disassembled by loosening the takedown screw on the right side of the action. The two-piece receiver separates to expose the working parts for easy cleaning.

The Micro-Groove barrel has long been a Marlin trademark. Marlin claims this multi-grooved (16 grooves) system has consistently produced fine accuracy because it grips the bullet more securely, minimizes distortion, and provides a better gas seal. I have no way of verifying those statements, but I do know the 39A is accurate.

Winchester's 9422XTR puts classic Model 94 big game rifle styling into a rimfire lever action. It's a neat, lightweight outfit, pushing the scales to only 6 1/4 pounds. A positive lever action and bolt design controls feeding and chambering. The bolt face is T-slotted to guide cartridges from the tubular magazine into the chamber. I experienced no feeding or chambering problems even with Shorts. The 9422XTR features an exposed hammer with half-cock safety. Ejection of empty cases is from the side. A color-coded magazine follower shows when the magazine is empty.

Accuracy from the 50-yard benchrest with target ammo ran in the 1¼ inch category, which puts the 9422 in the squirrel-hunting realm. It's really a smooth operating outfit and has a classic look. Stock and forearm are American walnut with a straight-grip design in the 9422XTR standard model. The sighting arrangement consists of a hooded bead front sight and a semi-buckhorn rear sight. The receiver is grooved for scope mounting.

Browning's BL-22 lever shows a classic design. Built in Japan, it has a short throw action, a 33-degree arc, and carries the trigger with it. Browning says this prevents finger pinching between the lever and trigger on the upward swing. Working the lever down and up ejects the empty, cocks the external hammer, and feeds a new cartridge out of the tubular magazine into the chamber. The trigger pull reading on my scales varied between 4 and 5 pounds and was clean and crisp without noticeable creep. This classy Browning has an inertia type firing pin with an exposed hammer that features a half-cock position. This is a definite safety feature on the compact lever rimfire.

The BL-22 has a 20-inch barrel with a bead front and a folding rear sight. The receiver is grooved for scope mounting. The forearm and straight grip stock are of polished walnut. It is offered in two grades — I and II. The latter has an engraved receiver and trigger guard along with a checkered stock. Grade II has a gold-plated trigger, which to me doesn't seem appropriate on hunting rifles.

Range tests with target ammunition kept groups sizes well within the acceptable limits for long range squirrel shooting. I broke the one-inch mark occasionally, but for the most part 5-shot groups at 50 yards average around 1¼-inches.

At one time, there were quite a few slide or pump action rimfires on the market. As far as I know, the number is now down to just two — Remington's Model 572 and Rossi's Model 62SA.

In 1938 I had the opportunity to use a Remington 12A slide action on the trapline. I was convinced it was the greatest rimfire rifle ever made. But a neighbor boy was just as adamant about his grandfather's Stevens 75 pump. During the early 1930s, Savage had a Model 29 slide action 22 on the market and Winchester was in the rimfire pump business with their Model 90 takedown and a lower priced Model 06. There may have been others I wasn't aware of, but the slide action 22 enjoyed a good bit of popularity prior to World War II.

Somewhere around 1936, Remington brought out their Model 121 Fieldmaster. It was truly the classic slide action rimfire of that time, and it had little competition, at least in my opinion, from Winchester's Model 61 pump or the Savage Model 29. The Savage 29 had to be respected; it could

trace its origin back to 1903 and later models came out in 1909 and 1925. But to my eyes the Model 29 never stood on equal footing with the Remington Fieldmaster.

I dreamed of owning a sleek 121 Remington from the day I handled one in a local hardware store. I was a junior in high school, and trying to become a proficient trapper. But I never got the 121. Its staggering price of around $30 was more than my meager trapline income could afford.

That wasn't the only disappointment in the 22 pump story. The Remington Model 12A that I had so much faith in belonged to a bachelor neighbor. He was out of work and couldn't get credit, and he needed a suit in a hurry. A mail order store was offering a complete suit, shirt, tie and socks for $19.95, and my neighbor had only $5. He tried to sell the Model 12A, finally reducing the price to $10. That was about half of what he had paid for it new a few years before. I knew it was the chance of a lifetime, but there was no way I could accumulate that kind of money in two or three days. In the midst of the Great Depression no one was foolish enough to lend a sixteen-year-old kid that kind of money. I tried, but in the end the Remington went to a more proficient trapper who knew how to catch foxes and minks. It was a low period in my life, and I still think about it occasionally. Ironic as it may sound, I still don't own a Remington pump 22, fifty years after carrying that 12A.

The slide action 22 has a certain mystique that is difficult to explain. It's almost impossible to pick one up and not think of rapid fire. No other action generates this feeling. Maybe it's because we often refer to shooting a slide action as "rattling" out the shots. The slide action is the fastest manually operated action, and many pump fanciers strive to perfect a rapid fire style. I too am a victim of the rattling syndrome. When I test a slide action rimfire on the range, my finale is rattling half a dozen shots through the trombone action. It's just something that seems normal with a pump rimfire.

I have already stated the pump isn't famous for pinpoint accuracy, but I'm not taking a middle-of-the-road stand in saying it belongs in the squirrel woods. The squirrel rifle reflects the philosophy of the squirrel hunter. Like my friend who wanted the Browning BL-22 to match his Model 81 BLR 308, the type of rifle is and should be a personal thing. The rimfire's accuracy potential satisfies the person using it. It can fail my standards and still satisfy someone else. Those who hunt in thick timber where shots are relatively short can use almost any type of rimfire. Maybe I have put too much emphasis on long range accuracy. It's possible that thousands of squirrel hunters could not care less about putting 5 shots in one inch at 50 yards. Even though that's my criterion for a top squirrel rimfire, it certainly doesn't have to be yours.

Current Big Game Cartridges

JUST IN CASE the idea exists that cartridges date back only to Civil War days, we'd better mention that Leonardo da Vinci referred to something by that name in the early 1500s. The question remains whether da Vinci was discussing a rumor, an item he was working on, or referring to something already invented. Neither is it known whether the cartridge he mentioned was directly related to the assembly of components for a firearm. So I'll depart from that long gone time and get to cartridges that most of us have known about or used for decades.

Big game cartridges are designed to give sufficient velocity to reasonably heavy bullets to assure adequate penetration and, usually, expansion in large animals that have heavy skeletal frames. Since not all big game animals have the same type of bone and muscle structure, certain cartridges are designed primarily for specific purposes. In other words, the 378 Weatherby Magnum isn't designed for whitetail deer. The 378 Weatherby falls into the moose and Alaskan brown bear category. The relatively new Remington 7mm-08 is much smaller than the 378 Weatherby Magnum. It's far from a moose or grizzly cartridge, but it is more than adequate for white-tailed deer.

The hunter must decide which big game cartridge is adequate for the game being hunted. Velocity alone cannot be the paramount factor. The 220 Swift has a blistering 4000 fps muzzle velocity, but its lightweight and fragile bullet would be a poor choice for animals the size of elk. It's a varmint cartridge first last and always.

The bullet is of prime importance in a big game cartridge. A solid, large-caliber 500-grain slug may be ideal for stopping an elephant, but the whitetail hunter can successfully use expanding bullets ranging from approximately 90 to 180 grains in weight. For super big game such as elk, moose and the big bears, deep penetration is necessary, and this means the bullet must stay in

These are the three best known 6mm cartridges at this time, the 243 Winchester, 244 Remington, and 240 Weatherby Magnum. All are extremely accurate high velocity loads.

one piece. Expansion is just as important on such game, for that is what creates wound volume. As the bullet moves through the target, it must uniformly expand and still retain much of its original weight. A bullet's makeup must be directly related to the size of the target. Big game cartridges are designed to give such results. Here is a quick look at the popular American loads.

Winchester 243

There are three factory 6mms: the 243 Winchester, 6mm Remington, and Weatherby 240 Magnum. The 243 Winchester is nothing more than the Winchester 308 necked down to take the .243 bullet. Winchester introduced it in 1955 as a combination cartridge for varmint and medium size big game. The deer hunter has much tougher bullets today. For instance, Hornady's 100-grain round nose and 100-grain spire point are constructed to give good penetration along with controlled expansion. Speer's 105-grain spitzer is an ideal long range deer cartridge, and Nosler's partition spitzer bullet is excellent in either 95 or 100 grains.

Remington 6mm

The same year the Winchester 243 was introduced, Remington offered their version of a 6mm cartridge, the 244 Remington, in their M722. The story is now pretty well known that the 12-inch twist they used would not reliably stabilize spitzer bullets above 90 grains. This reduced the versatility of the 244 cartridge. In 1963, Remington renamed the cartridge the 6mm Remington. The 244 and 6mm Remington cases are exactly alike, both being based on the 7 x 57mm case necked down with a slightly sharper shoulder angle. The 6mm Remington has 9-inch twist, so handles the heavier bullets well.

One of the most frequent questions tossed at me is whether the Remington 6mm is better than the Winchester 243. Ballistically, the 6mm Remington has a tiny edge, but the hunter will never notice it. Since the switch to the new name and a faster twist, the 6mm has become very popular for varmints and deer-size game.

240 Weatherby Magnum

Weatherby's 240 Magnum is the most powerful of the 6mm's. It generates higher velocity than either the 243 or the 6mm, and this might be worth considering for long range deer hunting with, say, the 105-grain Speer spitzer, Sierra's 100-grain boattail Game King, or Hornady's 100-grain Interlock spitzer boattail.

The 240 Weatherby has about the same powder capacity as the 30-06. In fact, it is darn near a belted 30-06, as it has the same rim size as the 30-06. Weatherby introduced it in 1968 as a new cartridge, but its dimensions are very close to those of the 240 belted rimless Nitro-Express put out by Holland and Holland two years after I entered this earthly sphere, or 1923. The case is belted and has Weatherby's double radius shoulder. Some experts claim the belt is not needed but is just used to dress up the cartridge. That may be true, but I like it, and the ones I have fired raised the adrenaline in my bloodstream. It stands at the head of the class for long range 6mm deer hunting.

Savage 250-3000

Stepping up to 25 caliber takes us back to 1915. That's the year Savage introduced the cartridge which became famous as the 250-3000. Charles Newton of Newton rifle fame designed the cartridge for the 100-grain bullet, to make it a truly suitable deer cartridge. Marketing stepped into the picture, due to the advertising volume the new cartridge would have with a velocity of 3000 fps. No other factory offering at that time could boast that much speed. Consequently, bullet weight was reduced to 87 grains to obtain the desired velocity at safe pressure. The new cartridge was dubbed the 250-3000. In the black powder days, many cartridges were designated by caliber and the amount of power they used — such as the 45-70, which meant a 45 caliber bullet and 70 grains of black powder. Savage just changed the arrangement to caliber and velocity and came up with 250-3000.

In my younger days the 250-3000 was either loved or hated. Big game hunting in Pennsylvania at that time was mostly woods hunting, and hunters of that period opted for heavy bullets. Even the 100-grain bullet in the 250-

3000 didn't have much appeal compared to the 35 Remington's 200-grain, say. The average Pennsylvania deer hunter wanted a big bullet for the dense laurel thickets and heavy timber stands. Western hunters appreciated the high velocity of the 250-3000, and its popularity induced Savage to offer it in their bolt action Models 20 and 40, as did Winchester in the Models 54 and 70 rifles. The 250-3000 with a 117-grain bullet at 2600 foot seconds is an ideal deer cartridge, and this cartridge is no slouch in the varmint realm with bullets in the 75/90-grain class. Unfortunately, the 250-3000 never made the grade as a super varmint cartridge, but it's the parent cartridge for Jerry Gebby's legendary 22 Varminter, which was standardized by Remington in 1965 as the 22-250. I made hundreds of 22-250s by just running 250-3000 cases into a 22-250 full length resizing die.

The 250-3000 survived the World War II years, but the advent of the 6mm's in the '50s sent the flashy combination cartridge into the sunset. Maybe I'm just reminiscing, but I believe the 250-3000, now that good bullets in the 100-grain class are available, is a better big game cartridge than the 243 or 244.

In 1987 I had the opportunity to hunt with a M77 Ruger RSI chambered for the old 250-3000 cartridge and carrying an aged Weaver V7 scope. Here again I have to admit that the accuracy with Remington 100-gr. soft point bullets wasn't spectacular, but few 3-shot groups spread much over 1¾ inches, and that's deer accuracy.

The first morning of Pennsylvania's antlerless deer season that year found me in McKean County watching a sloping pipe line. A few minutes after 9 a.m. I was caught by surprise when I saw a deer standing along the edge of the cleared right of way some 75 yards distant. It was a perfect standing ribcage shot, but I almost blew everything with I reached for the rifle lying on a nearby stump. The doe was halfway across the 30-foot wide swath before I picked her up in the scope. I swept the reticle in from behind her and, as it crossed her neck, fired. The deer just collapsed.

I watched for a moment to be certain it was a clean kill, feeling the 100-gr. slug had hit either the neck or the back bone. When I examined the doe, I found the bullet had struck the rear of the shoulder three inches down from the backbone. There was no exit hole so I reasoned the lightweight bullet had disintegrated, possibly cutting the spinal cord. Part of my assumptions were correct. The bullet had blown to bits almost instantly, doing considerable damage to the internal organs, and a half-dozen fragments had damaged the opposite shoulder. However, no fragments were found in the back.

My bullet had struck a fatal area and caused an instant kill, which is what every hunter wants. Still, I can't overlook the deficiencies of the lightweight

bullet and say the 100-gr. slug in the 250-3000 is a perfect deer getter. On the other hand, I don't want to downgrade the old cartridge. This might seem like I'm taking a middle-of-the-road position, but if more young or small and hunters used the 250-3000 with the 100 or 120-gr. bullets, they could be more successful in the deer woods than they are with more powerful loads. Since this little speedster is low in recoil, practicing is a lot more fun. I have more faith in the 250-3000 than in the 6mm's because a heavier bullet can be used.

257 Roberts

A lot of older hunters wouldn't forgive me if I didn't put in a word about the 257 Roberts. Like the 250-3000 and 25-06, the 257 can be used in the deer woods or chuck pastures. N. H. (Ned) Roberts, a gunwriter from the gaslight era, created the 25 Roberts from the 7x57mm Mauser. A variety of cartridge dimensions were tried, but the final case was the 7x57mm necked down to accept a 25-caliber bullet. Sometime around 1928, the Niedner Rifle Co. produced the first factory rifles.

In 1934, Remington introduced a standardized version of the Roberts with the case shape changed slightly to aid in factory production. The shoulder angle was changed from 15 degrees to 20 degrees. At that time, the factory cartridge was officially called the 257 Roberts to avoid confusion with the custom rifles which had a 15-degree shoulder angle.

For woods use on deer, the 257 Roberts is every bit as good as the 25-06, to my way of thinking. It gets the job done with little fuss. For many years it was considered one of the most versatile cartridges ever to hit the hunting scene. It works equally well with both varmint and big game bullet weights, giving an 87-grain spitzer up to 3300 fps for chucks and a 117-grain 2800 fps for deer.

Remington 25-06

In 1920, A. O. Niedner developed the 25 Niedner. It's simply a 30-06 necked down to accept the 257 caliber bullet. Through the years, many neck angles were experimented with, but none offered any particular advantage over the standard 17 degree 30 minute angle of the 30-06. With old custom rifles, it's wise to have a gunsmith make a chamber cast to see if modern factory ammo will be safe to use.

During the early life of the 25 Niedner, its performance was limited by the lack of slow burning powders. The picture brightened when powders such as

4350 and 4831 became available. The slower burning powders help get maximum efficiency out of the heavy 117/120-grain bullets.

In 1969, Remington put the 25-06 on the market to stay. The 25-06 can handle a wide array of bullets, but big game hunters should stick with the heavier weights. In fact, long range shooters will get top results with the 120-grain spitzer boat tail bullet. Several manuals show this bullet can hit a sizzling 3100 fps with maximum handloads, which makes it really impressive for long range work on deer-size game.

257 Weatherby Magnum

In 1944, Weatherby came out with the 257 Weatherby Magnum. It's based on a shortened 300 H&H case. This cartridge has had its share of controversy. Depending on which school of thought you come from, the 257 Weatherby Magnum is just a glorified 25-06 or it ranks just a shade below the 270 Winchester for big game. I'm not taking sides, but I can tell you that it has what I call a significant edge over the 25-06. It adversaries admit this is true, but claim it's at a price of higher pressures and shorter barrel life. Proponents say the 257 Weatherby Magnum had such an impact on the hunting fraternity that it prompted Winchester to bring out their 264 Magnum. You'll have to be the judge.

Don't let anyone kid you that the 257 Weatherby Magnum is not a super medium-size big game stopper. For long range use on game the size of deer, antelope and caribou, it's unbeatable. Velocities with the 117/120-grain

Deer cartridges don't need to be super magnums. Small to medium loads such as these, the 244, 25-06 and 7mm-08 Remington, 308 Winchester and 30-06, will do all that's necessary in most cases.

bullets can crowd 3300 fps, which gives a stretched-string trajectory — only 8 inches low at 400 yards when zeroed +3 at 100.

264 Winchester Magnum

It was a sad day for me when Winchester dropped the 264 Magnum, a 338 Magnum necked down to 6.5mm caliber. I don't know the exact reason for its demise, but some claimed the 264 was a barrel burner. This could be more truth than conjecture since Winchester tried stainless steel barrels on the 264 to deal with its 85-grain bullet at 3700 fps and its 100-grain at 3600, to say nothing of the 120 and 140-grain big game loads, at 3300 and 3150 fps. Stainless is more resistant to throat erosion than standard steel.

While it could be true the 257 Weatherby Magnum induced Winchester to bring out the 264 Magnum, it is not true that the 257 Weatherby has an edge over it on big game. The two cartridges are similar, but the 264 Winchester has the advantage of being able to give the heavier 140-grain bullet almost 3200 fps. That makes the 264 a more efficient large game cartridge, I believe.

6.5 Remington Magnum

The 6.5 Remington Magnum came along in 1966. It's the 350 Remington Magnum necked down for the 6.5 (.264 diameter) bullet. It appears the best bullet for the 6.5 Remington Magnum is the 120 grain, which Remington lists at a muzzle velocity of 3200 fps, which might be optimistic. The short overall length of the 6.5 Remington Magnum magazine, 2.8 inches, inhibits the use of heavier bullets. They have to be seated so deeply in the case that powder capacity is reduced. Nevertheless, the 6.5 Remington Magnum is unquestionably the best of the 6.5 cartridges on the market today. In case you're not aware of it, a number of 6.5 cartridges are available, including the 6.5 Japanese, 6.5 x 55mm Swedish, 6.5 x 52mm Mannlicher Carcano and the 6.5 x 54mm Mannlicher-Schoenauer. The best loads in all of these give 140-grain bullets about 2400 fps, which means they are good woods cartridges.

6.5 Carcano

The 6.5s are relatively small in powder capacity, and they do adapt well with the 120-grain bullet. I found many of the ex-military rifles to have wide variations in bore diameters, and I found few that could be considered accurate. Probably the best known import is the 6.5 Carcano, often called the 6.5 Italian. It sold like crazy right after World War II, and it didn't carry a high price tag, which was the main reason they had such terrific appeal. Many unsuspecting buyers thought that since the 6.5 Italian was a military

creation, it would be similar in quality and accuracy to our Krag, Springfield and Enfield. That belief was short-lived, believe me. A few Carcanos I tested made respectable groups, but others wouldn't hit a saucer three times out of five at 100 yards.

270 Winchester

The 270 Winchester is in a category of its own. It was introduced in 1925 in the Winchester Model 54 bolt action outfit. It is a necked down version of the 30-06. It survived a storm of criticism during its early life, and has become one of the most popular cartridges in North America. The late Jack O'Connor, considered the dean of gunwriters for many years, was an avid fan of the 270. He hunted around the world with the 270, and took many big game animals during four decades of use.

I am certainly not going to criticize the 270, but I don't have any inordinate affection for it, either. I can't see carrying a 270 when I can get more efficiency from the 30-06. The 270's recoil is a bit lighter, and in open country its flatter trajectory might be a better choice than the 30-06 on lighter big game. It's also claimed, and I don't dispute it, that the 100-grain 270 bullet with its 3400 fps velocity is right at home in the varmint fields. But I just can't buy using the 270 for chuck or prairie dog hunting. For one thing, recoil is going to be a factor if there are plenty of targets, and it doesn't have the pinpoint accuracy of various centerfire 22s and 6mm's.

The 270 is capable of consuming a wide variety of bullet weights. Factory loads are available with 100, 130 and 150-grain bullets. While the 270 was basically designed for the 130-grain bullet, it can produce impressive ballistics with the 150-grain spitzer, and handloaders can use bullets of from 90 to 180 grains.

I can end all this by saying that the 270 Winchester cartridge has been around a long time, and there's not one thing I can see in the future that will diminish its popularity. It is a very fine versatile cartridge.

270 Weatherby Magnum

The 270 Winchester was the only factory cartridge in 277 caliber until the 270 Weatherby Magnum was announced in 1943. This is a shortened, necked down, sharp shouldered version of the 300 H&H Magnum. Some gunwriters claim it was the 270 Magnum that started Weatherby in the gun business around 1945. However, the 270 Weatherby has never been as popular as the 270 Winchester, though there's no denying it is one of the best cartridges for long range work on most North American big game species. The 150-

grain spitzer boattail bullet is a wise choice for the Weatherby 270 Magnum.

7mm Mauser

In 284 caliber, the old 7mm Mauser (7x57mm) held the spotlight for many years. It began life as a military cartridge way back in 1892. Shortly afterwards, it was adopted by the Spanish government in their Model 92 Mauser. Contrary to popular opinion, especially now that we are being hypnotized by the magnum syndrome, the 7mm Mauser is one of the best deer cartridges available. I'm not sure whether any non-custom manufacturer now chambers for the 7mm Mauser, but its popularity is still high enough to keep fresh factory ammo on the score shelves.

The feeling prevails that the 7x57mm is an underpowered cartridge. Well, if you consider the 270 Winchester underpowered, I guess you are right. You see, the 7mm Mauser is only a power step below the 270, which in turn isn't too far down from the 30-06. There is also an extensive bullet selection for handloaders in the 7mm line, and this assures the 7mm Mauser cartridge a healthy existence.

7mm-08 Remington

Remington's 7mm-08 is a relative newcomer, dating from the early 1980s. The 7mm-08 wildcat, which had been around for years, was turned into the 7mm-08 by Remington for their Models 788 and 700 bolt action rifles. Remington then dropped the Model 788 and added the Model Seven. To my way of thinking, the 7mm-08 in the Model Seven is an ideal deer rifle, especially for the young hunter and the distaff side of the

The 284 caliber is represented here by the very old and the very new — the 7x57mm Mauser and 7mm-08 Remington. A wide selection of bullet weights and styles is available in 7mm; one or another will handle most American big game.

family. Recoil is not excessive, the 140-grain factory load at almost 2800 fs is just right for deer, and the Model Seven is an accurate, easy-to-carry lightweight rifle. My good friend Dick Dietz, supervisor of product information at Remington, thinks the 7mm-08 is the best cartridge for medium size game in the nation. I have to agree.

280 Remington

The 280 Remington was introduced in 1957 in the Remington Model 740 autoloader. Even though it was an excellent cartridge, it did not spark a lot of interest. In 1979, Remington reintroduced it as the 7mm Express. Now Remington chambers the Model 700 Mountain Rifle for this cartridge, and has changed the name back to 280.

The 280 is essentially a necked-down 30-06, so fits between the '06 and the 270 Winchester. It's very close to the '06 in performance, and Remington claims it has comparable or better down range performance than either the 270 or 30-06. The 140-grain bullet is my choice for deer, but large game hunters should stick with 160 or 175-grain slugs. The 280 Remington is truly an all-purpose big game cartridge.

284 Winchester

I'm a strong believer in the 284 caliber, and I also believe that the Winchester 284 cartridge is one of the finest deer cartridges ever to come out. Winchester introduced it in 1963 in their Model 88 Winchester lever action outfit and Model 100 autoloader. It represents the first American cartridge to be designed with a rebated rim; that is a rim that's smaller in diameter than the case body. Its main drawback stems from the fact that heavier bullets have to be seated overly deep to feed through the magazine of the Model 88, and this reduces powder capacity.

To my knowledge, no rifles are currently being chambered for 284, and that's a shame. With the 140-grain bullet, handloaders can break the sizzling velocity of 3000 fps in a bolt action, which makes it a genuine long range outfit. The brush hunter can use either the 160 or 175-grain bullet. While the 284 may be obsolescent, that doesn't mean it isn't a top cartridge for medium size game.

7mm Remington Magnum

In 1962 Remington introduced their 7mm Magnum in conjunction with their new line of Model 700 bolt action rifles, which replaced the 721, 722

and 725 models. I think it's fair to say that the 7mm bullet (284 caliber) is the best compromise for long range shooting. It's efficient but has reasonable recoil. Larger diameter bullets have to be heavier to have the proper sectional density and flat trajectories needed for long range shooting. Going too far down in bullet diameter generates another problem. Small caliber bullets lack weight, hence they won't retain high velocity nor will they penetrate well.

The Remington 7mm Magnum cartridge was an immediate success, and many manufacturers chamber for it. I'm somewhat opposed to large calibers for varmint hunting, but I have to admit that Helen and I used a 7mm Magnum for several years for long range chuck shooting. We used Speer 115-grain hollow point bullets that chronographed at over 3350 fps. It was a super bullet, and Speer claims the 115-grain hollow point was specifically designed for varmint shooting with the 7mm Remington Magnum.

Many old-time wildcatters compare the Remington 7mm Magnum with the 7x61 Sharpe and Hart Magnum brought out by Phil Sharpe and Dick Hart in the early '50s. Actually, Remington's 7mm Mag is not completely new, for it's similar to several earlier wildcat designs (by Ackley, Mashburn and others), but as a commercial design it came along at precisely the right time and it's probably the best compromise cartridge for all types of North American big game.

7mm Weatherby Magnum

Weatherby's 7mm Magnum came along in 1944. As with the 257 and 270 Weatherbys it's based on the shortened 300 H&H Magnum case. Although it had nearly two decades of life before the Remington 7mm Magnum was introduced, it hasn't generated as much attention. It can handle the full range of 284-caliber bullets, but it's probably at its best with the 160-grain spitzer boattails, which it will blast out at 3100 fps.

30-30 Winchester

The 30-30 is the granddaddy of all deer cartridges. It came out in 1895 in the Winchester Model 94 lever action rifle, and was one of the first sporting rifle cartridges loaded with smokeless powder. It has probably killed more deer than any other cartridge. Over seven million Model 94s have been sold, and a maze of makes and models of rifles have been chambered for the 30-30 cartridge.

The 30-30 is at home with either the 150 or 170-grain bullet. The 30-30 was never intended to be a long range cartridge, but bolt action shooters can add

yardage by using 150-grain spitzer bullets. Heavier spitzer bullets need more velocity than the 30-30 cartridge can deliver.

High velocity loads should be avoided in lever action 30-30s as this case is relatively thin and such guns are really not strong enough to withstand the pressures of high velocity loads.

300 Savage

The 300 Savage cartridge dates back to about 1920, when Savage introduced it in their Model 99 lever action rifle. Many hunters think of the 300 Savage as being a cartridge of low velocity. The truth is that the 300 is not too far below the 308 and 30-06 velocity readings. It can push a 150-grain slug out the muzzle at 2600 fps, and that's plenty of speed for ranges up to 250 yards. Handloaders should be able to work up excellent deer loads with the 125 or 130-grain bullets which add more yardage.

307 Winchester

The 307 Winchester came along in 1983 when U.S. Repeating Arms Co. offered the Model 94 Winchester lever action with side angling rather than top ejection. This allowed a scope to be mounted directly over the bore instead of offset to the side of the receiver or ahead of the action.

The 307 carries essentially the same exterior dimensions as the 308, except that it has a 30-30 type rim. Dissecting the 307 case showed it had thicker walls than some 308 cases, which cuts down on powder volume. Therefore, although these two cases are similar, do not use 308 data when loading 307 cases. And despite the similarity in case dimensions, the cartridges are not interchangeable. That could cause dangerous results.

From limited range tests, I tend to think of the Winchester 307 as a souped up 30-30. The 180-grain flat nose should give super results in the woods at its velocity of just over 2500 fps. The 150-grain flat nose generates well over 2700 fps and would be my choice in open terrain.

308 Winchester

Winchester's 308 cartridge derives from the military 7.62mm NATO which was originally the Army Ordinance T-65 rifle and machine gun cartridge. It was introduced in 1952 as a commercial cartridge by Winchester for their Model 70 bolt action rifle and their Model 88 lever action outfit.

There are some pretty hot arguments over whether the 308 is as powerful a cartridge as the 30-06. It was designed to replace the 30-06 as a military

cartridge, and it's also very popular for big game hunting. However, due to the 308's lesser case capacity, it cannot be ballistically equal to the 30-06.

I have killed four deer with the 308 in a Ruger RSI Mannlicher M-77 bolt acton outfit. While it may not be quite as powerful as the 30-06, no hunter could ask for a finer deer cartridge. For whitetails, I lean toward the 150-grain bullet, which can hit over 2800 fps at the muzzle, but I would switch to the 165-grain boattail in wide open country. The 165-grain Sierra boattail hollow point has a high ballistic coefficient of .440, and its velocity is only a shade under the 150-grain spitzer's. Elk and moose hunters should stick with the 180-grain factory load or perhaps the Speer Grand Slam or Nosler Partition. Such bullets are tough and will penetrate well on even the largest game animals.

30-40 Krag

The 30-40 Krag cartridge had its sporting hey day during the Depression Era, after being used in the U.S. military service from 1892 to 1903. The long uncut Krag, costing less than $15, was the choice of countless Pennsylvania deer hunters in those money-starved days. My late gun dealing brother-in-law, C. J. Clawson, told me he bought 30-40s in lots of 100 still boxed for overseas shipment. He paid around $3 each and sold them for $12.

The Krag's designation derives from its caliber and original powder charge. The first number, 30, indicates its caliber, and the second, 40, designates the powder charge in grains of its original loading. It was sometimes call the 30 U.S. Army magazine rifle, and its design was a modified version of the Krag-Jorgensen used in Norway and Denmark.

An original Krag is a collector's item today. The Krag can be considered a dying species. Not many are seen in the big game woods anymore. While the 30-40 is not as powerful as the 30-06, being more on par with the 308, it performs well with both 180 and 220-grain bullets. It holds the distinction of being the first U.S. smallbore military cartridge and the first to be loaded with smokeless powder. The Krag rifle is well known for its smoothness. It has the slickest, smoothest bolt ever put on a rifle.

30-06

The 30-06 has to be the best known big game cartridge in the United States, possibly in the world. Introduced in 1906, which accounts for its name — Ball Cartridge, Caliber 30, Model 1906 — the '06 captured the hearts of the military and millions of big game hunters around the world. Originally, it was a military cartridge, a modified version of the rimless 1903 cartridge which utilized a 220-grain round nose bullet at 2300 fps at the

muzzle. Early on, the 30-06 was loaded with a 150-grain bullet at some 2700 fps. Around 1926, a 172-grain boattail bullet was introduced at the same velocity, but this was lowered to 2640 because of pressure problems.

As the storm clouds of World War II gathered on the horizon, the military went back to the 150-grain bullet at 2700 fps, which performed better in the then-new M1 Garand Rifle than the 172-grain load.

One of the 30-06's attributes is its ability to handle a wide range of bullet weights. With bullet weights of factory ammo running from 150 to 220-grains the '06 will take care of most North American big game animals. The deer hunter will be hard pressed to find a better bullet than the 150-grain spitzer. During the years I operated my sight-in range, I almost always got better 100-yard accuracy from the 150-grain bullet than the heavier ones. Conversely, I never had much success with 110-grain handloads in the chuck pastures. Probably the twist was too fast for these short light bullets.

A variety of new thin-skinned big game cartridges are making inroads on the 30-06's popularity and there's no getting around the fact that several of these cartridges, particularly the 280 and 7mm-08 Remington creations, are ideal for much North American hunting. Nevertheless, many shooting experts claim that the 30-06 is still the best choice for the one-rifle hunter. I won't argue against that.

300 H&H Magnum

Magnum big game cartridges are not new. For instance, the 300 H&H Magnum was introduced following the first World War by the famous British firm of Holland & Holland. It was originally called the Super 30. In the U.S., Western Cartridge Co. began loading this cartridge about 1925, when only custom rifles were available for it here. In 1937, Winchester began to chamber their great Model 70 for it. It generated a considerable following in this country, and is still considered a top big game cartridge. It handles all 30-caliber bullet weights, but those in the 180/220-grain class would be my choice for the bigger species. For super long range shooting, the 165-grain spitzer boattail handloaded to 3150 fps or so will fill the bill nicely. This weight will do the job on medium size game and maintains a flat trajectory when shots stretch way out there.

300 Winchester Magnum

In 1956, Winchester started to produce a series of belted magnum cartridges. The 300 Winchester Magnum was the fourth and last in line. It's about the same overall length as a 30-06, so works nicely in standard length

actions, but of course is bigger in diameter. To maintain a large powder capacity, the shoulder was moved forward and the neck shortened. The 300's only drawback is that short neck, which means that long bullets have to be seated deeply.

The 300 Winchester is an accurate high velocity load, and has made a name for itself as a 1000-yard competitive cartridge. Remington chambered their 40XB heavy barrel target rifle for the 300, which is an indication of its effectiveness. The 300 Winchester will take a broad range of bullet weights, but is designed for game animals well above deer and antelope in size. The long range big game hunter is well off with a 180-grain spitzer bullet having a muzzle velocity rubbing the 3000 fps mark, while 200 and 220-grain loads are available for the big bears at close range. The match shooter usually opts for a 190-grain match boattail.

300 Weatherby Magnum

I think my feelings about the 300 Weatherby Magnum being the most powerful readily available 30-caliber big game cartridge will be accepted as ballistically true. With proper bullets, the 300 Weatherby has sufficient killing power for large game animals the world over. I know that, due to bore diameter, it is prohibited in some countries, but that doesn't take anything away from this super big game cartridge.

Many reloading manuals and articles on the 300 Weatherby state that it can be reloaded for varmints. I suppose it's possible to reload even the 50-caliber machine gun cartridge for varmints, but that doesn't make it a varmint cartridge. The 300 Weatherby, in my humble opinion, is too much cartridge for medium size animals, let alone varmints. For one thing, the 300 Weatherby's muzzle blast and heavy recoil (upwards of 50 pounds) aren't conducive to comfortable shooting. Not too many hunters are willing to run through a box of 300 Weatherby ammo for practice.

The 180-grain bullet at 3100 fps is tops for North American big game, but even more energy will be produced at longer ranges by the 200-grain spitzer boattail loaded to 3000 fps. Handloaders should stick with magnum primers as the large charges of slow-burning powders used in the 300 Weatherby are hard to ignite.

32 Winchester Special

The 32 Winchester Special has been hanging around for over 90 years. The cartridge, which was loaded with smokeless powder but could be reloaded with black powder, was designed for the Model 94 Winchester rifle back

before the turn of the century. In that era, smokeless powder was not as easy to get as black powder. The main purpose of the 32 Winchester Special was to give the hunter the opportunity to reload the 32's case with black powder. From a logical viewpoint, the 32 Special should have died before World War I, but rifles don't wear out quickly so it's still with us.

The 30-30 has a rifling twist of 1 turn in 12 inches, but the 32 Special was made with a much slower twist of 1 turn in 16 inches, to better handle black powder loads. The drawback with the slower twist is that once it starts to wear, accuracy goes out the door. As far as I know, no rifle manufacturer now chambers for this vintage cartridge, but you can bet your best hunting boots that it will survive for years.

8mm Mauser

Germany's 8mm Mauser (8 x 57mm) cartridge was adopted by that country's military establishment back in 1888. The original bore diameter was .318. Bore diameter was increased to .323 in 1905. In some areas overseas, both diameters are available, and the larger .323 diameter is designated as S or JS.

The 8mm has never been popular in this country, although when World War II ended many GIs who had fought in Europe brought them home as souvenirs. Probably most of these were dismantled so the excellent Model 98 Mauser acton could serve as the basis for a custom rifle.

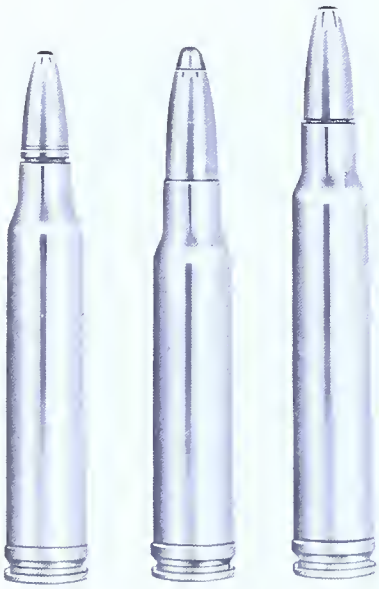
The 8mm can be loaded close to the 30-06 in terms of velocity and energy, and is capable of taking any North American big game. Handloaders should check the bore diameter to make certain it will accept the .323 bullet.

I have shot a lot of 8mm's with both 150 and 175-grain bullets. I always liked the higher velocities of the 150-grain bullet on deer, but an elk or moose hunter would probably get better penetration with heavier weights. A reasonable selection is available.

8mm Remington Magnum

The 8mm Remington Magnum is another one of those excellent cartridges which for some reason was not a commercial success. Maybe the metric designation had something to do with it — that and the fact that it was an 8mm. It took Americans generations to recognize the efficiency of the 7mm's, and World War II GIs came home with an aversion to 8mm's, so maybe all these factors had a total effect which kept the 8mm Magnum from catching on.

Ballistically, this big belted case is impressive. At 2.85 inches, it's the same length as the original 375 H&H. Overall length of the cartridge is 3.6 inches,



These three belted magnums — Winchester's 300 and 338 and Remington's 8mm — will handle the biggest American game easily and most African stuff as well.

so a magnum-length action and bolt throw is required. Factory loads feature 185 and 220-grain bullets at 3080 and 2830 fps, respectively, which means energies approach the 4000 fp level. That's enough for the biggest American game and a lot of the African stuff. Nevertheless, after being introduced in 1977 it was dropped from regular production in 1984, though it is still available from Remington's custom shop in the Safari Grade M700. The hunter who wants one cartridge that will handle everything on this continent should give the 8mm Remington Magnum serious consideration.

338 Winchester Magnum

As mentioned earlier, beginning in 1956 Winchester brought out a series of belted magnums. The 338 Winchester Magnum was born in 1958 when Winchester necked down their 458 cartridge to 338 caliber. They introduced the new cartridge in the Model 70 "Alaskan" bolt action rifle. At present, several other rifle manufacturers plus many custom gun builders chamber for the 338.

The 338 Winchester is a very powerful cartridge. Factory loads crowd 4000 foot pounds of energy and many handloads top that. The 338 is designed to stop the largest North American big game animals, and it has a solid reputation in Africa. Like the 300 Weatherby Magnum, the 338 cartridge is prohibited in some countries where the 375 caliber is the smallest allowed for certain big game animals. We might say that using bore measurement as the basic criterion in such a situation seems a strange way to go about things. For example, the 375 Winchester deer cartridge, which has a muzzle energy of some 2000 foot pounds, apparently would be a legal cartridge in those countries, while the 300 Weatherby and 338 Winchester, with energies above 4000 foot pounds, are illegal.

Bullet weights for the 338 Magnum run from 200 to 300 grains. Various 200-grain spitzers, plus the 210-grain Nosler Partition, Hornady 225-grain Spire Point and Sierra's 250-grain spitzer boattail are excellent choices for long range use on most anything in North America or the big African antelope. The 250-grain Nosler Partition, Speer Grand Slam or Hornady round nose will certainly handle elk, moose and our biggest bears, as will the 300-grain Barnes and the heavy weights of several new custom bullets such as the Trophy, Star and Kodiak bonded bullets. Everything considered, the 338 Magnum is a most impressive cartridge.

340 Weatherby Magnum

Weatherby's 340 Magnum is a strong competitor to Winchester's 338. It was made by simply opening up the neck of the 300 Weatherby case to take .338 bullets. Weatherby brought it out in 1962, after watching the Winchester 338 sweep through the big game hunting ranks. Basically, the two cartridges are similar — they use the same diameter and weight bullets — but in several load combinations, the 340 has a noticeable edge. It has to burn a lot more powder to show an appreciable velocity gain, though, and naturally the more powder the higher the recoil. The 340 fits neatly into the niche between the Weatherby 300 and 378 Magnums.

The same bullets are used in the Weatherby 340 Magnum as in the Winchester 338 Magnum. The dyed-in-the-wool 338 fan will never be convinced the 340 Weatherby Magnum is a better long range sheep or goat cartridge, but the 340 Weatherby Magnum fan is just as certain it is.

348 Winchester

I have to touch on the 348 Winchester, a cartridge brought out in 1936, discontinued in 1958, and resurrected by Browning in the mid-'80s. Maybe it isn't common knowledge that the Model 71 lever action Winchester, an update of the great M86, was designed especially for the 348 Winchester cartridge. Over the years, I disassembled a great number of rifles, and no other one had higher quality workmanship than found in the Model 71. Its top ejection necessitated side mounting if a scope was required, but I managed to convince every owner who came to my shop not to drill into the sidewall of the beautiful Model 71. I never drilled a hole in a Model 71 Winchester.

For a good many years, the 348 held the distinction of being the most powerful rimmed cartridge in a lever action rifle. Yet, it never qualified as a long range cartridge. It's at home where the brush is thick, shots are short, and fast action is necessary. The 348's 200-grain flat nose bullet is driven out the muzzle at better than 2450 fps, and that's pushing a big slug pretty fast.

35 Remington

Remington brought out the 35 Remington cartridge in 1908, in their Model 8 autoloading rifle. Later, Remington chambered both the Models 14 and 141 pump action rifles for the 35. A fair selection of bullet weights is available, but the old 35 Remington is a proven brush-buster and the 200-grain slug fits the same category, so that's probably the best choice.

Perhaps there really isn't a brush-busting rifle or bullet, but the term gets a bit of use. It came into vogue when deer hunters frequented dense stands of timber and laurel. The brush was thick and the shots were close. It was in this type of terrain that the 35 Remington earned its reputation. The 200-grain bullet, hitting about 2100 fps, didn't deflect easily, and it had close to 2000 foot pounds of muzzle energy that didn't drop much on a 50-yard shot. The 35 is superior to Winchester's 30-30 and 32 Special mainly because of its bigger-diameter and heavier bullet.

As a big game cartridge, the 35 Remington is slowly fading from the scene, but handgun silhouette shooters are using the cartridge in the Thompson/Center single shot Contender.

358 Winchester

Winchester introduced their 358 cartridge in 1955, and chambered both the Model 70 bolt action and Model 88 lever action rifles for the new cartridge. The 358 is a 308 necked up to accept a 35-caliber bullet. It has a slight edge over the discontinued 348 Winchester cartridge, and is much more powerful than the 35 Remington. However, it didn't set the world on fire, and Winchester discontinued it. Nevertheless, it's an excellent woods cartridge for most of our big game.

350 Remington Magnum

In 1965, Remington brought out their 350 Magnum cartridge in conjunction with their handy Model 600 bolt action carbine. A decade after Winchester brought out their 358, Remington offered a stubby, belted head, short neck, magnum rifle cartridge. The 350 Magnum can give a 200-grain bullet 2700 fps or a 250-grain 2400 fps out of an 18½-inch barrel. This makes the 350 Remington an excellent heavy slug outfit that is most at home where the game is on the big side, the cover is heavy and the shots are short.

35 Whelen

Many younger shooters have never heard of the 35 Whelen. It was created

about 1922 by gunsmith James V. Howe, apparently following the suggestions of gunwriting great Colonel Townsend Whelen. In fact, it was named for Colonel Whelen. The 35 Whelen offers near-magnum performance in a standard length action. The 35 Whelen was for decades the most popular wildcat big game cartridge. Remington standardized it in early 1988 in the Model 700 Classic (a limited edition) and M7600 slide action, an excellent timber rifle. It is scheduled for regular production in the M700 BDL beginning in 1989.

The 35 Whelen is a 30-06 case necked up to 35 caliber. It is powerful and flexible enough for all types of North American big game. Remington is offering factory loadings with 200 and 250-grain bullets. This former wildcat develops well over 3000 foot-pounds of muzzle energy with each bullet weight, a figure not achieved by any other non-magnum American cartridge. Brush hunters who long dreamed of owning a custom 35 Whelen but could not afford one, will be able to go back to the "good old days" with the affordable Remington Model 700 now being chambered for the famous 35 Whelen.

375 Winchester

In 1978, Winchester gave woods hunters the 375 Winchester in a heavy duty version of their Model 94 lever action outfit. This 375 is not a magnum. It's a sort of modernized 38-55. I know many long range big game hunters wonder why the large caliber, short range cartridges remain popular. Well, a large segment of deer and bear hunters across the nation have great faith in large caliber, modest velocity cartridges for short range timber shooting. The 375 Winchester meets their every need. In factory loads, a 200-grain bullet has 2200 fps, a 250-grain, 1900. Energies top 2000 foot pounds. Hornady offers handloaders a 220-grain flat point designed specifically for the Winchester 375. Muzzle velocities can top 2100 fps with this slug.

375 H & H Magnum

The famous English gun making firm of Holland and Holland introduced their big belted 375 H & H Magnum in 1912, and Winchester chambered the Model 70 for it in 1937. The 375 H & H became a legend in Africa and is considered by many American big game hunters to be the ultimate for moose, elk, and our biggest bears. Bullet weights run from 235 to 300 grains. The 375 H & H Magnum pushes a 270-grain slug out of the barrel at 2700 fps and a 300-grain at over 2500. Such ballistics explain why the 375 H & H

Magnum is holding up very well in the hunting realm. New magnum cartridges are making inroads, but the future is far from gloomy for the old 375 H & H.

378 Weatherby Magnum

The 378 Weatherby Magnum and I have more than a passing acquaintance. I fired this brute more than 175 times in range and chronograph tests. My records indicate that I easily obtained muzzle velocities of over 3050 fps with the 270-grain slug. I remember that dumping power charges of some 110-grains in the big case was like shoveling coal in a furnace.

Book figures show that the 270-grain bullet will generate over 5500 foot pounds of energy. This is truly a cartridge for super big game. It has no reasonable place in the deer woods.

Remington 416

In 1988, Remington offered hunters a new dangerous game cartridge, the 416 Remington Magnum. It provides a combination of energy and bullet construction capable of handling any of the world's largest and most dangerous game.

The Remington 416 is based on an 8mm Remington Magnum case necked up to 416 caliber. It is offered with 400-grain soft point and solid bullets loaded to a muzzle velocity of 2400 feet per second and a muzzle energy of 5115 ft. lbs. This is about a 10 percent increase in muzzle energy over the 458 Winchester Magnum loaded with a 500-grain bullet. Here's something else worth remembering. Due to its smaller caliber and higher velocity, the energy superiority of the 416 Remington Magnum increases progressively as shooting range increases. In comparative soft point bullet performance, it provides an energy superiority of 18 percent at 100 yards and 30 percent at 200 yards.

The 416 Remington Magnum meets the three criteria for a dangerous game cartridge: It has sufficient energy for large and potentially dangerous game, proper and dependable bullet construction in both soft point and solid form,and it is available in a reliable repeating rifle action.

The 400-grain pointed soft point bullet has a tough partition design that provides rapid initial expansion that stops no more than halfway down the bullet length and remains locked at that point without further expansion or breakup under the most destructive impact. The 400-grain solid is just that, a true solid rather than a jacketed lead core design. It is turned and shaped

from solid brass and will not break up or overexpand on the toughest, thickest-skinned African big game.

Despite its 400-grain bullet weight and high energy level, the 416's soft point loading produces a trajectory line roughly equivalent to that of the 375 H & H Magnum. This means the 416 Magnum can be used on North American moose and elk at long range.

At 100 yards, the 400-grain soft point is still hitting 2175 fps and offering over 4200 fp of energy. At 200 yards it retains over 3400 fp of energy. At the 300-yard mark it still produces over 2700 fp of energy.

444 Marlin

The 444 Marlin came along in 1964, chambered in Marlin's Model 336 lever action rifle. Winchester had discontinued their 348 cartridge a few years earlier, so the 444 Marlin took over as being the most powerful lever action load at the time. It held that rating until Marlin brought out their Model 1895 chambered for the old 45-70, which can be awfully impressive with handloads. Top muzzle velocity for the 444's 240-grain slug runs about 2400 fps, and going up to the 265-grain drops the MV to just over 2100. As with the other big caliber, low velocity cartridges, the 444 Marlin is best suited for brush and thick timber stand hunting.

45-70

The 45-70 cartridge has been around for well over a century — since 1873, to be precise. In those days it was called the 45-70-500, the numbers deriving from the caliber, 45, the grains of black powder used in the load, 70, and the bullet weight in grains, 500. It was originally used in the M1873 Sringfield, a single shot rifle commonly called the "trapdoor" model because of its unusual method of opening and closing the action — actually the rear end of the barrel — for loading and unloading. This was a weak system and accounts for the low pressure level still maintained in factory-loaded 45-70 ammo, as many of these guns, and other weak designs, are still around.

However, the 45-70 is a rather large capacity case and it handles heavy bullets well, so when a strong action is used, this cartridge can be handloaded to impressive levels. Actually, in recent years there has been a resurgence of interest in the 45-70, and several levels of handloads have been developed in response to this situation. First is the factory-equivalent stuff, which essentially uses 300 to 400-grain bullets at perhaps 1450 fps. Then there are loads suitable for the famous M1886 Winchester. This lever action dates from the last century, through Browning recently marketed some of current

manufacture. Such loads are noticeably more powerful, and even more so are those developed for the modern Marlin M1895. None of these are long range combinations, but they can well handle elk and moose in thick cover. And then there are what might be called maximum 45-70 loads, those suitable for the extremely strong Ruger No. 1 and No. 3 single shots and bolt actions such as custom jobs built on Siamese Mauser actions. The latter can often handle 500-grain bullets at 1800 fps or so, which delivers 3600 foot pounds of energy. I'm not going to list any specific loads — all the good manuals do that — but you can see this old cartridge has lots of potential in the right guns.

458 Winchester Magnum

The 458 Magnum was Winchester's answer to the needs of American hunters who flocked to Africa when things settled down after World War II. The traditional double-rifle cartridges used on the biggest game in East Africa prior to that war — those in the 470 class — delivered about 5000 foot pounds of energy. However, there simply weren't enough of those great old guns around to meet the demand, and the few available had extremely high price tags. Winchester satisfied hunters' needs with a brand new 45-caliber belted magnum case that was short enough to work through a Model 70 action and had enough powder capacity to give a 500-grain bullet 2100 fps and the magic 5000 foot pounds of energy. Maybe no bolt action — not even the legendary Model 70 — could have the glamour or romantic background of a Holland & Holland double rifle, but the M70 was an awful lot cheaper, far more accurate, could fire twice as many shots without reloading, and was available. The M70 458 Winchester Magnum soon came to dominate the regions that held the world's most dangerous game. Such efficiency is not needed for North American hunting, of course. I'm not saying an Alaskan hunter easing through the alder tunnels in brown bear country would feel overgunned with a 458 — or even a 37mm — but in all likelihood a 338 will handle his shooting chores. Obviously, there's no need whatsoever for a full-loaded 458 in any other American situation. The 458 Magnum was created for Africa, and that's where it shines.

Personal Experiences With Some Big Game Cartridges

HELEN HAS USED a Model LSA 65 Ithaca 25-06 for many years. It's not only a classic rifle, it's also a very accurate outfit. She likes its classy looks and the fact that it has a detachable magazine. Topped with a 2-7x Redfield Widefield, she claims it's the best deer rifle in the woods.

At noon on the second day of a recent antlerless season, Helen informed us she was through hunting. She claimed there were no deer in that area, and she didn't care if she ever saw another deer. With the 25-06 slung over her back, she headed down a wide powerline cut. Dr. Dennis Olsen from Kane was directly behind her, I was next, and Bill Nichols brought up the rear. Helen's frustration came from being the only one in the group who didn't have a deer.

Before we moved a hundred yards, a doe jumped out on the powerline and stopped about 60 yards away. Well, for a certain person who had quit hunting and didn't care if she ever saw another deer, she went into action at an unbelievable pace. Wild Bill Hickok in his prime would have been hard pressed to match her speed. I thought she would fire too quickly, but she took plenty of time getting into a comfortable offhand position and dropped the doe with a neck shot. When I asked why in the world she would chance an offhand shot at the neck when the entire ribcage was visible, she asked in a rather teasing way, "Why would I shoot at the side of a deer when the neck is just as easy to hit?" I didn't bother to reply.

Remington 6mm

Shortly after the 244 Remington cartridge was introduced, a friend bought one chambered in Remington's 722A bolt action outfit. I had a Model 722A chambered for the Remington 222. My varmint hunting friend and I would often trade outfits. Work prevented him from hunting bucks the

I dropped this northern Pennsylvania buck at 232 steps as it sneaked through some pines. Redfield 4-12x and 7mm Remington Magnum 140-gr. load did the trick.

first Saturday of deer season, and I borrowed his 244 and a box of handloads stuffed with 100-grain Hornady bullets. He referred to this load combination as his "special" deer loads. We were anxious to see how the 100-grain 6mm bullet would react on game the size of deer.

By mid-afternoon, only one small doe had passed, and I decided to move. I drove for about a mile, and not more than a minute after walking into a small wooded area, a buck raced across a wide pasture field and up a brushy slope. Just before hitting the top, the buck stopped behind a small thicket of brush and looked over it in my direction. I had shot groundhogs in the pasture field from the hillside, so I knew it was over 250 yards to the buck. A rotting snag made a perfect rest, and I cut loose just as soon as the crosswire in the 6x Weaver settled high on the buck's neck. I lost sight of everything when the 6mm cracked, but I couldn't see the buck after I fed in another round. After about two minutes of searching the hillside, I decided I had missed. Still, I couldn't figure how the buck got over the top of the hill without me seeing it. It hadn't, I found out a few minutes later. The 100-grain Hornady had hit the neck dead center.

Remington 7mm-08

Bill Nichols and Fred Anderson had scored earlier on two fat does, but Helen and I hadn't seen a hair. It was getting close to quitting time on the first day of the 1981 antlerless season, and I was wondering if I would have to take another day away from the office to get a shot. I didn't want to do that as I had a backlog of work there. While these annoying thoughts were churning through my mind, a shot rang out high above me. Naturally, I turned and started to watch the hillside. In less than a minute, a doe came trotting down and hit the flat I was on. That was what I was waiting for.

I slipped off the safety of the Model 788 Remington 7mm-08 and picked

up the moving deer in the scope. When things looked right, I shot. The deer stopped and looked around. Just before I could shoot again, the doe started trotting across in front of me. Again, I swung with the deer and pulled the trigger. The doe stopped, but this time she must have smelled me. I cut loose a third shot as she bounded up a hillside, but the doe never flinched. I bolted in the last round just as she slowed to a walk. I rested the 7mm-08 against a small sapling and picked up the walking deer. This time, the 140-grain Remington factory round found its mark.

30-30 Winchester

During all my years of testing and hunting, I used Winchester's famous 30-30 cartridge on just one deer hunt. Now, I look back on that hunt as one of the most frustrating I have experienced. Gunshop problems prevented me from hitting the deer woods on the first morning of buck season until 9:30. Worse yet, I had locked my deer rifle in the shop. When I discovered that, I was really upset and grabbed a M340 Savage 30-30 that Helen had intended to use if a bad sinus problem cleared up by noontime.

Helen often uses this LSA M65 25-06 for woodchucks in the summer, so she's fully familiar with it when deer season rolls around in December.

When I finally arrived about 10 o'clock at a snow covered area overlooking an abandoned stripmine, another hunter was sitting on a seat I had erected several days before behind a large stump. Now, I was three times as mad as I had been over agreeing to wait for a customer until 8 o'clock. At 9 o'clock, he hadn't arrived and I gave up. Having to use the 30-30 made me twice as mad, and finding another hunter in my stand had me next to bursting a blood vessel.

Shooting and yelling far down in the strip job apparently prompted my visitor to leave. When he disappeared into a heavy pine stand several hundred yards away, I finally got to sit on the seat I had built. Everything looked hopeless, and I was sure the area had been wiped out. While enduring my mental misery, a movement a hundred yards down in a small hollow caught my eye. It was a buck.

Before I could shoot, it moved up on a hillside that was dense with saplings. It stopped and I took a long rest and fired. I heard a distinct thud, indicating I had hit a tree. I waited patiently as the buck moved a few yards and stopped. Again, I took careful aim and shot. The buck flicked his tail a few times, lowered his head and moved on. When it moved slowly through an open space, I put the crosswire on the shoulder and fired. The buck jumped slightly and then raced along the hillside for about a hundred yards. Then it broke into a trot directly away from me, and I let the fourth and final round fly. The buck reared up on its hind legs like a prairie mustang and headed uphill on a dead gallop. I watched helplessly with an open mouth and an empty rifle.

I picked up the buck's track where I had first seen it, and followed it along the hillside. I found nothing to indicate a hit, and I couldn't even find a bullet mark in the snow. When I reached the area of the fourth shot, the snow looked like a floor in a barber shop. Hair was everywhere. My hopes rose, but with no blood signs indicating a solid hit, I figured the 150-grain slug had only grazed the buck.

I had no alternative but to follow the trail up the hill. I had to smile when I discovered the buck had stepped in a snowcaked spot where a hunter had stood that morning — if he had only waited. Since I was on top of the hill, I leaned against an oak to contemplate the chain of events. I glanced out into the woods, and there was my buck ambling back in my direction. My first impulse was to fire, but I had already been through a four-shot episode that produced nothing but hair. This time, I would keep time and patience on my side. I did. When I lowered the 30-30 with a satisfied smile on my face, there were still three cartridges in the magazine. Oh, by the way, one of my first shots barely nipped the hair of the back, and the fourth shot had raked a

skin-deep swath across the right hip.

Tom Hooks used his Steyr-Mannlicher 243 to connect on a 140-yard running shot at this 8-point. Shoulder shot gave an instant kill.

7mm Mauser

The 7mm Mauser (7x57mm) should see a lot more use in Pennsylvania's deer woods than some of the more powerful cartridges. It's not a relic from the late 1800s, as some feel. However, I feel that the newer Remington 7mm-08 is a wiser choice for Pennsylvania whitetail hunters.

I once dropped an antlerless deer with one shot from a No. 1 Ruger 7x57. It was less than 100 yards, but it was really thick. I was using a 175-grain Speer Grand Slam bullet. It centered the ribcage, but there was not enough resistence to make the bullet expand properly. The deer ran about 90 yards. The 175-grain Grand Slam is intended more for bear, elk and moose. I would have been better off with a 140-grain bullet.

Remington 7mm Magnum

This cartridge has been a favorite of deer and black bear hunters for decades and will continue to be. A wide array of bullet weights can be used, but I prefer the 140-grain for deer.

Late one afternoon, I was high on a spoil pile watching over an abandoned strip job. Nature was slowly taking over the worked-out mines, and numerous small pines and saplings covered a gentle sloping spoil pile 250 yards from me. I was engulfed in dark shadows, but the opposite hillside was still in bright sunlight.

It appeared to be another fruitless hunt, but my spirits were brightened by a doe trotting across the top of the hillside. I checked for antlers through my 4-12x Redfield. It was a doe for sure, but I watched as she slipped easily through the maze of sapling and trees. She broke into a wide clearing just before disappearing. I was startled to see another deer following, and I didn't need a scope to see its rack.

I pushed the safety off the No. 1 Ruger 7mm Magnum and picked up the

Bill Nichols checks deer trail in snow, his custom 257 Roberts at the ready. He likes this little cartridge's accuracy and efficiency, as proved on many hunts.

trotting buck in the scope. Several times I wanted to shoot, but the buck kept disappearing behind clusters of pine trees. Then I remembered the opening the doe had gone through. I swung the Ruger well ahead of the buck and waited. As it trotted across the treeless section, I was able to keep the 4-Plex reticle on the buck's shoulder. I kept the rifle moving as I pulled the trigger. I heard a resounding thud and saw a flash of white in the scope. The buck was down. The 140-grain bullet hit three inches behind the shoulder for an instant kill.

30-06

One of the drawbacks of being a gunwriter stems from the fact that, over the years, many big game rifles are sent for testing. Throughout the course of a big game season, I may hunt with three to five different rifles. While this may sound exciting, there are disadvantages. The main stumbling block is never getting the feel for one rifle. Using a pump Remington on a morning hunt and a bolt action Savage in the afternoon can be confusing. Without exaggeration, I have carried a 30-06 in one brand or another on no less than a dozen deer hunts, but only scored twice, and both times were on antlerless deer.

Right after lunch, on the second day of the antlerless season, I missed an easy shot at a trotting deer. I was using a 110-C Savage 30-06 bolt action topped with a Burris 3-9x scope. I had the rifle zeroed in two inches high at 100 yards, and the doe was crossing a wide pipeline right of way about 160 yards from me, so I had a dead on hold. I was shooting from the sitting position, but the 165-grain Federal boattail bullet failed to connect.

I joined Bill Nichols and Milt Anderson around mid-afternoon. They

were following several deer they had seen earlier. As Nichols came to a ridge and surveyed the slope below, he motioned for me to move up beside him, which I did. I could faintly see a deer standing about 150 yards below. Before I could raise the rifle, another deer stepped into an open spot. I lost no time in resting the Savage against a tree and touching off a shot. The 165-grain bullet dropped the deer instantly.

While I have had only limited success with the 30-06, I think it would be my choice as the all-around big game cartridge. From talking with many successful '06 users, I believe the 150-grain bullet is best for deer. I would up the bullet weight to 165-grains if shots farther than 200 yards were common.

308 Winchester

The rain came in sheets the first morning of the 1983 buck season. The shiny new Ruger M-77 RSI Mannlicher 308 carried a 2-7x Redfield Widefield Low Profile scope that I had been testing since July. I tried to protect it, but I finally laid it on top of a stump and let nature take its course. By noon, I was soaked and disgusted. However, a change of clothes and a bowl of hot soup revitalized me for a trip back to the same spot. Fortunately, the rain had ceased, and I stood on a ridge overlooking a deep valley.

Shots rang out across the valley and I could hear someone yelling about a buck. One lone shot rang out, and I figured that was the coup de grace. I started to put the Ruger back on the stump when a movement below caught my eye. It was a small buck with the poorest set of antlers I had ever seen. It was moving at a fast trot, and I waited for it to cross a clearing almost a hundred yards below. I fired the instant the buck's shoulder hit the crosswire intersection in the Redfield. It was an instant kill. The 130-grain Speer hollow point hit just behind the shoulder, a mere two inches below the back line.

Early Varmint Cartridges and Wildcatting

IT'S ONLY FAIR to mention that the 22 caliber was not the only popular rimfire cartridge. The 25 Stevens, 30 Long, 32 Long, 38 Extra Long, and a black powder creation known as the 44 Henry Flat were some of a long line of rimfires that filled niches for hunters and shooters of the gaslight era.

When the self-contained primer made its appearance in the centerfire cartridge, the heyday of the lower power rimfire cartridge was over. Another side benefit that came with the new priming method was a potential for cartridge case modification. With the rimfire, the cartridge designer had no way of installing the priming compound in the case. Priming was done when the case was manufactured. A rimfire cartridge was simply tossed away after being fired; little else could be done with it. With the centerfire's replaceable self-contained primer, it was possible to use a case over and over, and gun buffs soon saw the potential for modifying a conventional case into a different form, what we now term a wildcat cartridge. One of the oldest is the 30-06 necked down to accept a 25-caliber bullet. Today we know it as the 25-06. Another that comes to mind from the dark past is the 25 Krag. This was the 30-40 necked down to 25 caliber.

Moving up the ammunition ladder from the 22 rimfires we come to a group of .224 creations known as varmint cartridges. In one sense of the word, the term "varmint" is ambiguous. It doesn't signify one particular animal but it covers an array of pests including woodchucks, prairie dogs, ground squirrels, coyotes, crows and jackrabbits, just to name some. In other words, the name has been tacked to any small animal or bird that is a nuisance, causes problems, or is in some way objectionable to humans.

In the early days, varmint hunting wasn't a genuine sport; it was a means of ridding farmland of pests. When I was a youngster, farmers in my area waged a constant battle on raccoons, weasels, skunks, woodchucks and

crows. These animals wreaked havoc with crops and barnyard fowl. A neighbor lost over 50 chicks in one night to a pair of weasels. The killers were back the next night, but both ended up in traps set by my brother Dan.

Such pests had few friends among the men and women who tilled the land. Losing most of a freshly planted sweet corn patch to a flock of marauding crows not only intensified the dislike the farmer had for those birds but also made a significant impact at the summertime table.

There wasn't such a thing as a true varmint rifle back then. Whatever shotgun or rifle was handy sufficed. No special emphasis was placed on that type of shooting; the basic idea was to get rid of the "miserable critters." About the only time varmints were hunted was when they became a real nuisance. Few farmland people actually had time to hunt for these pests. Don't get me wrong, there were plenty of small and big game hunters from the days of the Pilgrims, but varmint shooting didn't have much to offer the supper table. Varmint shooters evolved from a combination of gun cranks, competitive shooters and cartridge designers.

Before varmint shooting gained a following of these shooting specialists in the early 1900s, the common 22 rimfire Long Rifle took care of all the farmer's requirements, from the first step in butchering hogs and steers to ridding the hayfields of woodchucks. Some single shot rimfires cost as little as $1.50. The inexpensive 22 in the kitchen corner was an essential farm tool when the land was plowed with oxen and horses. And it didn't die when more powerful 22-caliber centerfire cartridges appeared. But from the dedicated varmint hunter's perspective, the little 22 rimfire lost much of its appeal when the high velocity numbers came along.

For almost five decades, the 22 Hornet cartridge, which was introduced in the early 1930s, has been heralded as the first true centerfire varmint round. That's not quite true. Incidentally, there was a cartridge called the 22 Hornet before the turn of the century. About 1893, Rueben Harwood, a famous writer-rifleman of the time, developed a cartridge which he called the 22 Hornet. As near as I can gather, Harwood's Hornet used a 48-gr. typemetal bullet and a powder charge made up of DuPont No. 1 Rifle Smokeless and FFg Semismokeless to obtain a velocity of 1900 fps. The 22 Hornet that we know is often said to be a development of Colonel Townsend Whelen, Al Woodworth and Captain Woody, of the Springfield Armory.

Captain Grosvenor Wotkyns, who later collaborated with Whelen on the Hornet, had experimented with the 22 WCF case using 45-gr. metal case 5.5mm Velo Dog bullets. Both accuracy and velocity were excellent, and the cartridge performed to a high degree for varmint shooting.

Colonel Whelen certainly made a significant contribution to the birth of

the Hornet, at least in publicizing it, but in all fairness, the design may have stemmed from the Wotkyns cartridge. It was shortly after Wotkyns' experiments that Whelen, Woodworth and Woody realized the potential of using the 22 WCF case with a 45-gr. .224 bullet. They conducted extensive tests with a modified 22-caliber M1 Springfield. This required rechambering the barrel, and altering the firing pin from rimfire to centerfire.

There's no question that several fast-burning powders and different bullet weights were tested, but the best results came from DuPont 1204 powder behind a 45-gr. jacketed bullet. With this combination, the rifle was capable of consistent 1½-inch groups at 100 yards. At 200 yards, the Hornet was around the 3-inch mark. That type of accuracy may be unimpressive by today's standards, but it made the Hornet deadly on varmints up to 175 yards or a bit more, which excited a lot of shooters in the '30s. Back then, the M1 22-caliber Springfield rechambered for the Hornet was considered the most accurate outfit. This was due in part to the strong bolt design, its fairly heavy barrel and one-piece stock, and the fact that the M1 Springfield had the correct weight and proportion for the new entry.

It didn't take the varmint-hunting fraternity long to find the Hornet, and it also didn't take the rifle builders long to get into the act. At first, the Hornet came from the ranks of custom gunsmiths such as R. F. Sedgley, Inc., of Philadelphia. He usually used Springfield actions and barrels made by Winchester. In 1933, Sedgley offered a WCF "Hornet" in a Mannlicher version and also a left-hand sporter model that carried the stiff price tag of $135. The firm also produced a neat single-shot built on the Winchester Model 87 action.

Many hunters consider the Hornet to be the first genuine varmint cartridge. I've had good results with a number of them, including the Anschutz 54S, KKJ Walther and No. 3 Ruger shown here.

Savage soon came along with the Model 23-D, which may have been the first commercial Hornet offered. Then Stevens brought out their famous Walnut Hill single-shot Hornet. It was made in several barrel weights including a 28-inch heavy and a 29-inch extra-heavy. Then Winchester more or less stole the show with the famous Model 54 Hornet. The M54 had long been made in larger calibers, but the Hornet was its first 22-caliber version. It more or less set the standards that all other Hornets were measured by.

Other custom rifle makers such as Griffin & Howe, Niedner, and Dubiel helped introduce the Hornet with their special high-grade outfits. They converted many Springfields, Ballards and other top actions to the Hornet chambering.

I doubt if I am exaggerating when I say there was a mad rush for this superior varmint cartridge. It's easy to understand why. Varmint shooters of that era were struggling with the likes of the 22 rimfire and 25-20 WCF. The rimfire's maximum effective range was no more than 75 yards — its was better at 50 — while the 25-20 was about a 135-yard outfit. When the Hornet appeared, with its sizzling muzzle velocity of 2300 fps with a 45-gr. bullet, it was heralded as a super cartridge. It was the load the Depression-era varmint hunter was looking for.

I have been an admirer of this tiny cartridge for decades, and I collected cigar boxes of chuck tails with the Hornet over the years. Still, I find it hard to understand the mad rush for the Hornet that occurred in the '30s. On the surface, it appears the Hornet was the first rain on the varmint desert since the self-contained cartridge was manufactured. That's not true. During all this scrambling, the old 22 Savage High-Power just stood on the sidelines — as it had since 1912. The 22 High-Power was actually a .228-caliber. It had been designed by Charles Newton, who based it on the 25-35 necked down. It was introduced as a commercial cartridge by Savage Arms in the Model 99 lever action rifle. Not surprisingly, its high muzzle velocity, exceeding the 3200 fps mark with a 55-gr. bullet and 2900 with a 70-gr., tagged it immediately with the devilish name of "Imp." It accumulated some following among deer hunters who were intrigued by its velocity in those days.

I'm well aware that the 22 High-Power wouldn't offer a high accuracy level in a lever action rifle. It also might be that Savage never intended it for varmint shooting and therefore didn't design a bolt action rifle for their creation. In 1912, the varmint hunting clan was sparse. It's of little significance now what the thinking was back then, but it amazes me that more experimenters didn't come up with heavy barrel bolt action versions for the 22 High-Power. In such an outfit the 22 High-Power could have

satisfied thousands of early varmint hunters instead of being ignominiously scuttled. Hornady still manufactures .228 caliber bullets, but another firm told me they stopped making this diameter due to the danger of getting them mixed up with .224 bullets.

Savage produced the first factory 22 Hornet rifle in 1932, followed by Winchester in 1933. It's reasonable to assume that it took several years or so for the Hornet to become widely known among varmint hunters. I mention this because in 1935, about the time the Hornet was selling like hotcakes on a winter morning, Winchester brought out the 220 Swift.

The Swift was based on the old 6mm Lee Navy cartridge used in the M1895 Lee straight pull bolt action. The case was semi-rimmed and exceptionally strong. Making the Swift from the Lee Navy case required necking it down to take .224 bullets and changing the body taper and the shoulder angle slightly. The high pressure loads of the Swift gave a 48-gr. spitzer bullet over 4100 fps, an incredible muzzle velocity, especially in the mid '30s. Winchester was marching step by step with wildcatters in their quest for higher speeds — in fact, was well ahead of them.

Almost from the day of its inception, the 220 Swift was plagued with bad publicity. Gunwriters of that era claimed the Swift jumped pressures unaccountably, stretched case necks terribly, and was accurate only with full power, high pressure loads at velocities above 4000 fps. A large majority of the varmint shooters back then swallowed these falsehoods hook, line and sinker. Falsehoods or not, the adverse publicity killed the Swift for all practical sales purposes. Apparently it was just too big a jump, ballistically, for shooters of the time to understand and appreciate.

Many knowledgeable gun buffs, down through the years, have tried to revive the old cartridge, but myths and falsehoods are hard to kill. We have learned a lot about the old Swift since the late '30s and early '40s. We now know the Swift has little more tendency to stretch and thicken case necks than other high velocity varmint cartridges. The problem came from pushing the Swift to the highest velocity possible. Every handloader wanted to shoot it at over 4000 fps. Speed was everything to them.

I still can't believe that knowledgeable gunwriters back then would make such asinine statements. With all the wildcatting going on at that time, cartridge designers should have known that super high velocity usually works against accuracy. A baseball pitcher will not keep his control over nine innings if he throws nothing by super-fast pitches. The Swift is easily capable of hitting 4000 fps or better at the muzzle, but its top accuracy is usually produced at speeds several hundred foot-seconds below that mark. I have

shot many 5-shot 5/8-inch or less groups at 100 yards with a number of Swifts, but they weren't being pushed to the limit.

The Swift case is a very strong one. Still, when loading the Swift to near maximum velocity, the reloader must pay strict attention to the cases and trim and ream the necks as needed. However, it's wise to remember that when cases stretch, it will be only a matter of time until they separate near the solid head. To stay on the safe side, don't over-trim a case. After several trimmings, toss the case away.

The 21-degree shoulder angle on the Swift case never seemed steep enough to me. I thought a sharper one might help burn more of the powder inside the case and thus reduce throat erosion. Other fans obviously felt the same way, and some experimenters worked with "improved" Swifts. Improving a case usually means cutting the shoulder area of the chamber to a steeper angle and perhaps straightening the sidewalls, then fireforming the case to final shape. This of course increases its volume. But even the factory Swift had more capacity than it needed, so improving it in a conventional manner only added to the problems. One gunsmith named Wilson, I believe, approached things from a different direction and sharpened the shoulder angle by shoving it back in a die. This reduced capacity a trifle and — who knows — might have reduced erosion a bit. Regardless, no modified version of the factory Swift ever gained much of a following.

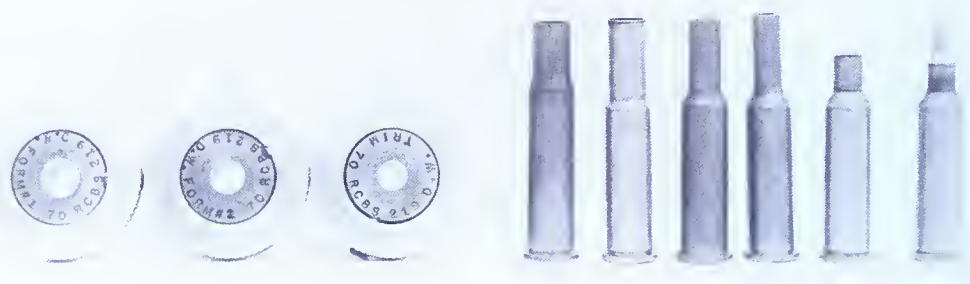
The 220 Swift was revived a few years back by Ruger in the M77 heavy barrel. At this writing, it's still available, but I doubt if it set many sales records. I have had a long association with this old cartridge, and consider it one of the finest long range varmint cartridges ever produced. Perhaps it is a little eccentric. Maybe it does require extra care. On the other hand, it's no more a barrel burner than a number of other cartridges, its bullets don't fly apart ten feet in front of the muzzle, and it doesn't set dry hayfields on fire with its muzzle flash.

I have little hope the 220 will ever make a real comeback. It will eventually meet the same ignominious end as have the 250-300, the 264 Winchester, and the 22 Savage High-Power. Over the years, the Swift played an important role in my chuck hunting career. No matter what its fate, I will always consider it the "King" of the 224 varmint cartridges.

Wildcatting

Several times, I have mentioned wildcatting. For decades wildcatting has been associated with drilling for oil or gas in areas that were previously thought to be unproductive. That's one type of wildcatting. However, the wildcatter I'm referring to is the tinkering handloader or gunsmith who

thinks he can create out of existing components a cartridge that is superior to existing factory cartridges. A wildcat cartridge is not in commercial production; it's usually one that has come into existence by modifying a standard factory case to accept a smaller or larger diameter bullet. This can be a one-step affair, such as shoving a 250-3000 Savage case into a 22-250 sizing die to reduce the neck size to accept the .224 bullet. Nothing else is changed in this example.



I used three RCBS dies to convert 30-30 cases into 219 Donaldson Wasps, plus a hacksaw, file and chamfering tool. It was a lot of work, but the Wasp was an outstanding varmint cartridge.

Making something like a 228 Ackley Magnum is a bit more complex. It is made from a 30-06 case, and it requires more operations. I use RCBS swaging and reloading press-type dies to do the job. The number one forming die shoves the shoulder back about $^{3}/_{16}$ inch. Number two forming die squeezes neck diameter down to about .285. At this point the case has to be cut off to the correct length. A hacksaw can be used to cut off the portion of case neck sticking out of the form/trim die, but I shorten cases on a Forster power trimmer used in conjunction with a drill press.

The power trimmer is nothing more than a small vise with the case-holding collet. The vise bolts directly onto the drill press table. Perfect alignment is made with a guide rod tightened in the drill press chuck and pushed into the collet. The drill press head is then locked and the guide rod is removed and replaced with a cutting tool which accepts various sizes of pilot tips. I tighten an already-made case into the collet, bring down the cutter until it touches, and then set the spindle depth adjustment to that point. For some reason it always takes several minor spindle adjustments to get things right, but, once set, it is just a matter of locking a case in the collet and bringing the cutter down on it. Really a breeze. After all the cases are run through the forming die, I shorten the necks with the power trimmer. The final operation is full length resizing to bring the case neck down to accept the .228 bullet.

The term wildcat does have a sinister sound because we automatically associate it with an old woods wildcat, a rather nasty fellow. Many wildcat cartridges have high velocities and loud muzzle blasts, which give the impression they are in a class by themselves. This isn't so. Wildcat cartridges have been around a long time. Some still in use today are fifty years old, but they've never achieved enough popularity to induce the ammunition companies to bring them out. The fact that they were bypassed is not necessarily an indication they were failures. A perfect example is the 219 Donaldson Wasp.

The Wasp was created in the late '30s by Harvey Donaldson, one of the all-time greats in the wildcatting and shooting game. Donaldson came up with the 219 Wasp about the same time Winchester introduced the 219 Zipper for their Model 64 lever action rifle. The Wasp was made by shoving the shoulder of the Zipper case back in a die, trimming off the excess neck length, and then fireforming the altered case to the final Wasp dimensions. Other rimmed cases of essentially the same rim diameter, such as the 25-35 and 30-30, could also be reformed into Wasps, and many were — particularly the 30-30 which I used with good success.

The 219 Donaldson Wasp was one of the most accurate wildcats of all time. Following World War II, the Wasp dominated benchrest shooting. I'm sure it would have been standardized by some ammunition manufacturer if the Remington 222 hadn't appeared on the scene. My first swaging efforts on the 219 Wasp were with hand tools of doubtful quality. I managed to make a few cases from once-fired 30-30 brass, but I ruined nearly as many as I made properly. On top of that, I had difficulty getting some of them into the chamber. This wouldn't have been a problem if the dies had been properly machined for my chamber.

I'm not a true blue wildcatter, but I enjoy case swaging. It never seems to be work to me. However, in the case of the 219 Wasp, I doubt if I would have continued if I had to make cases by hand. Dave Andrews of RCBS sent me a 3-die set of forming dies plus a set of conventional reloading dies, which eliminated the problems. With the RCBS press-type forming dies and Forster Power Trimmer, I was able to turn out a box of reformed cases in a matter of a half-hour.

Accuracy with the Wasp is uncanny. Even with my varmint rifle, which is in no way a benchrest job, I fired a number of 3-shot cloverleafs at 100 yards, and less-than-inch groups at 200 yards weren't unusual. The accuracy of my 219 Wasp literally killed any chuck-hunting alibi I could come up with. When I miss under 275 yards, I know who to blame.

With all the Wasp had to offer, it died a sudden death when Remington's

222 was born. The 222 gave essentially the same velocity and perhaps even better accuracy. I read somewhere that hundreds of Wasp fans switched to the 222 Remington, not so much for its accuracy, but because they didn't have to make cases for it. I can't substantiate that, but I know that my enthusiasm for swaging Wasp cases with the early vise-type hand tools waned a little with every case I tossed in the junk box.

It's worth pointing out that the wildcatter of the early days worked against staggering odds. In reality, wildcatting is a true mark of the rifle enthusiast, and that was doubly true in the early years. Major rifle building firms stuck with conventional cartridges, and admittedly they built fine rifles for them. But the wildcatter wasn't satisfied with what was being offered. He saw the need for cartridges that would fill gaps in the commercial lineup. It's true that early wildcat cartridges were basically commercial cases necked up or down to other calibers. For example, the 30-06 necked up to 35 became the 35 Whelen, and necked down to 25 caliber was the 25 Niedner. Probably the only new wildcat to use a case in it original configuration was the original 22 Hornet. It was the old Winchester 22 WCF loaded with smokeless powder and 22-caliber bullets from the 22 Velo Dog revolver cartridge.

Most early wildcatters were obsessed with high velocities. In almost every

My Wasp is built on a Mauser DST action with heavy Buhmiller barrel. With its T10 Weaver, 5-shot groups are usually under a half-inch. Cravener double-V rest is a great rig if little walking is necessary.

case I have read about, the designer of a wildcat cartridge was out to get a hundred feet a second or so more speed. When the shoulder weapon hit the scene, the black powder rifle, with its heavy slug, didn't offer much in the way of yardage. As time went on and it became necessary to kill game at longer and longer ranges, more velocity was needed and cases with more powder capacity were created. The big black powder buffalo cartridges are examples.

The advent of jacketed bullets eliminated barrel leading. They can withstand much higher velocities than lead bullets. With jacketed bullets the cartridge designer could almost use a carte blanche approach. When velocities passed the 3000 fps mark, the dream of the mile-a-second bullet disturbed the sleep of many wildcatters. That, in itself, may not be impossible. The 22 CHeetah will tick off around 4250 a second at the muzzle with a 55-gr. slug. Adding another 1000 fps is not necessarily an insurmountable problem.

The early wildcat specialist didn't know how fast his bullets were being pushed out of the muzzle. Top quality inexpensive chronographs such as the Oehler Chronotach Skyscreen outfit I routinely use now were not even dreamed of in the 1930s. Ammunition makers had chronographs, but these behemoths filled a room and took several technicians to operate. A few wildcatters used the services of ammo companies to get velocity readings on their entries, but many improvised. One method was to shoot into a steel plate with a commercial load of known velocity. The wildcatter would then fire his cartridge, of the same caliber and bullet weight, into the plate. Some thought that by comparing the penetration depths of the two it could be determined if the new cartridge had a higher velocity. This might explain why published velocities of the past aren't too reliable.

When it finally was recognized that a bullet could be pushed only so fast and still retain accuracy, goals began to swing away from sheer speed. The dream of the mile-a-second cartridge faded.

The early wildcatter didn't just spend an evening or two browsing through catalogs to select forming dies for his new creation. Factory swaging dies were yet to come. For the most part, his only choice was to machine from raw steel his new case's external dimensions. He had to build everything from scratch.

I can understand why the designer of a wildcat cartridge could be a bit overoptimistic about his offspring. But I also learned, during many sessions chronographing some of the old wildcats, that the designer often overestimated the velocity as much as 400 fps with some of the loads he recommended. There is a sneaky, but dangerous, way to get a high velocity

reading: use an above maximum powder charge in a very long barrel. I'm sure that happened many times. But most wildcatters were simply generous in reporting the performances of their pet cartridges. It's the same with hunters. Don't we all have a tendency to overestimate a fairly long deer shot? I did that, and our oldest son, who is a professional engineer, doubted my estimated figure enough to lug a transit for a half-mile to the spot I had shot from. To add to my embarrassment, I had to hold the stadia rod where the deer fell while he figured the distance. He proved I was 57 1/3 yards on the high side. The moral here is, don't let your kid become an engineer.

I'm willing to forgive those old-time wildcatters who got a little overoptimistic about their creations. The entire shooting fraternity owes a deep debt of gratitude to the likes of P.O. Ackley, Harvey Donaldson, Ned Roberts, C. S. Landis, Vernor Gipson, Jerry Gebby and dozens of other dedicated experimenters who stepped into the unknown to produce better cartridges.

It's safe to say that wildcatting peaked twice: from the late '20s through the '30s, and again for a few years after World War II. It's not dead by any means. The 22 CHeetah, created by well known gunwriter Jim Carmichel, is the latest wildcat. There are still guncranks who are determined to find the ultimate cartridge, and there are still a few specialized gun buffs, like those in the past, who won't touch a store-bought die or a factory reloading press. I had the good fortune to meet one of these specialists.

Sometime during the middle 1960s at a reloading seminar I put on at a shooting club, I demonstrated some of the equipment and tools then available. As I was packing to leave, an elderly gentleman asked me to shoot a couple of groups with his 219 Donaldson Wasp. He said he had built it literally from scratch, along with the necessary swaging and reloading dies. I'm not one to turn down a chance to burn someone else's ammo and, on top of that, I was curious to see his rifle and reloading gear. I assured him it would be my pleasure.

If my memory is correct, he had installed a heavy stainless steel barrel into a sleeved Model 98 Mauser action, and buried it in a benchrest-type stock he had made from a chunk of his own walnut. I know the rifle had Peerless set triggers. I had a similar set on a 220 Swift built on a Model 98 action, and he gave me several tips on polishing the sear to make mine a little smoother. He had an impressive looking outfit, which was further enhanced by a Lyman Super-Targetspot 25x scope.

As we walked to the range, he explained how he had made a cast of the 219's chamber, and then machined dies to swage 30-30 cases to the exact tolerances of the rifle's chamber. The reloading dies were made with the

22-250, left, legitimized by Remington after long popularity as a wildcat, and the 22 CHeetah, a new wildcat designed by Jim Carmichel and Fred Huntington.

same precision. He went on to say that for many years he had been dabbling with wildcat cartridges. In several instances he had designed a cartridge and then chambered a heavy barrel rifle for it. He implied his efforts never resulted in a super cartridge. For the most part, it was just a year or two of lost effort. But it was interesting. He didn't wildcat to make money; only to satisfy some inward urge. He wasn't egotistical, but he did feel that, eventually, he would come up with a super cartridge.

I didn't realize he wanted me not only to shoot, but also to reload a few rounds with his hand tools. I told him I'd had little experience with such tools, but was willing to give it a try. He produced a beautiful mahogany box that held a complete set of hand tools and swaging and reloading dies for the Wasp. It was obvious he was methodical to the nth degree. Everything, including screwdrivers, tools, dies and assorted gear, had its own place. Nothing was just tossed into the box. Another box, with a special rack, contained fifty little glass vials. Each held a precisely weighed powder charge and was sealed with a tiny cork. I could see instantly that his reloading tools and dies reflected excellent workmanship.

I didn't have time to make cases but, in about ten minutes, turned out five reloads. My efforts were a far cry from the smoothness he had displayed, but I managed to print a 5/8-inch group at 100 yards, which I felt was not bad for the first try. Not only was that type of reloading new to me, but I didn't have any warm-up shots to get the feel of his rifle's trigger. He didn't do too much better at 100 yards but he whipped the pants off me on the 200-yard target. I learned in a hurry he was not only a fine mechanic, but also a darn good shot. As much as I regret it, I've forgotten his name and even where this incident took place. I do know, however, that meeting that veteran gunsmith was a milestone in my life. I'd had a chance to see a true wildcatter at work. It gave me a small taste of the wildcatting past, and that was something rather special to me.

Current Varmint Cartridges

THE VARMINT CARTRIDGE is primarily designed for small pest-type animals such as woodchucks, prairie dogs, coyotes, crows, ground squirrels and foxes. Basically, the varmint cartridge utilizes a small diameter, lightweight bullet at high velocity. It often disintegrates immediately after impact, even on animals the size of prairie dogs. Some 224-caliber varmint cartridges are used for small to medium size big game, but many times such a bullet will fragment before it has a chance to penetrate adequately and this is doubly true if a lightweight bullet strikes heavy bone or muscle.

Larger caliber varmint cartridges are often used for medium size big game, but only heavy bullets or those designed for penetration should be used. The 6mm's will usually give good results on deer with bullet weights of 90 grains or more. In 25 caliber, the a 117-grain slug is deadly on deer. Helen has killed a number of deer with the Federal 117-grain soft point Hi-Shok bullets. This type of cartridge falls into the "combination" classification when heavier bullets are used.

22 Hornet

I can only surmise that during the black powder era a number of varmint hunters yearned for a more efficient cartridge than the 22 Winchester Center Fire. They had to wait until about 1930, when the 22 WCF was transformed into the 22 Hornet. Savage took the lead and chambered their bolt action Model 23-D for the Hornet in 1932. Winchester followed suit in their Model 54 in 1933. A new era in varmint shooting had begun. The 22 Hornet offered a significant increase in velocity over the 22 WCF, and this lowered the trajectory arc and made 200-yard shots reasonable. The Hornet was received with open arms and still has supporters today.

The 45-grain spitzer bullet is my choice in the Hornet. It can bump the

2700 fps mark, which is enough speed to stretch shots beyond 175 yards. Heavier bullets cut the velocity down considerably. The turkey hunter can use the 55-grain full metal jacket bullet with good results, but varmint shooters are best served with the 45-grain soft point.

218 Bee

The 218 Bee appeared in 1938 in the lever action M65 Winchester, with a great deal of media hoopla. Hornet fans rallied around their cartridge, claiming the Bee had nothing over their pet. In one sense, that's true, but from a pure ballistic standpoint, it's not. The 218 Bee has more powder capacity and is capable of higher velocities with a broader range of powders, perhaps 2800 fs with a 45-grain bullet. Also, the Bee handles 50 and 55-grain bullets more efficiently than does the Hornet. But the 218 Bee, like the 22 Hornet, is not a true high velocity or flat-shooting cartridge, and in the lever action M65 it was not highly accurate. It fell from prominence, along with the Hornet, when Remington brought out the high velocity 222.

222 Remington

It's claimed that a few wagon wheel ruts are still visible on the Oregon Trail, which dates back more than a hundred years. I have a strong feeling that the Remington 222 will still be popular in the year 2050, which will be about a hundred years after its inception.

In 1950, Remington introduced the 222 in their new bolt action Model 722 rifle. It was an instant success. First, it was an entirely new creation, not a modification of another case. More importantly, the 222 was extremely accurate, even in the standard weight Model 722. Several other 224 caliber cartridges had more impressive velocity, but few matched the 222's accuracy.

Benchrest fans took to the 222 like ducks take to water, and the 222 dominated the BR scene for nearly a decade. I have always contended that the 222 and home reloading, which was growing in popularity at the time of the 222's birth, made the average hunter accuracy conscious and added tens of thousands of shooters to the varmint hunting ranks.

The 222 is responsible for turning countless plinkers into group shooters. Before the advent of the Remington 222, few of us knew much about group shooting, except that it belonged in the competitive ranks. The 222 was easy and inexpensive to reload. Handloaders soon began to check their ammo from the 100-yard bench. I know that's the way I started to group shoot. Putting five bullets into less than an inch at 100 yards became the measuring stick for a varmint rifle. Helen and I poured many hundreds of rounds

through my M722 Remington 222, just testing loads and shooting groups. Standardizing the 22-250 has somewhat overshadowed the 222 for ultra long range varmint hunting, but the 222 has done its job. American hunters and competitive shooters have benefitted immeasurably from the little Remington case.

I consider the 222 a 250-yard varmint cartridge, but on windless days another 25 yards can be added. The 50 to 55-grain bullets are fully satisfactory in the 222, and I have stuck with 52-grain benchrest bullets for all-around hunting and shooting for a number of years. The 50/52-grain bullets can be pushed to over 3200 fps, and the 55-grain will get close to the 3100 fps mark. My tests with heavier bullets left something to be desired in regard to trajectory.

Remington 222 Magnum

The Remington 222 Magnum is now discontinued, but it's worth listing. It came into existence as an experimental round for lightweight automatic combat rifles. In 1958 Remington offered it as a commercial cartridge.

The 222 Magnum has several grains more powder capacity than does the conventional 222, and it holds a little more than the Remington 223. In

While I watch for results, Bob Bell prepares to let off a shot from his M77 Ruger 22-250. The 2-inch Unertl is a big heavy scope but provides unsurpassed optics and the utmost precision in aiming.

velocity it fits in about halfway between the 222 and 22-250. With some powder charges, the 222 Magnum can generate better than 3400 fps with 50-grain bullets. On a still day, the Magnum adds close to a hundred yards to the 222's effective range. Some benchrest shooters switched from the 222 to the 222 Magnum, due to the latter's higher velocity, but that helped varmint shooters more than accuracy fans. The advent of the Remington 223 was the death knell for the 222 Magnum, but it's still a fine long range varmint cartridge, and it's accurate, too.

223 Remington

The 223 Remington started life as a military round carrying the fancy handle of 5.56mm Ball Cartridge M193. It was developed sometime between 1957 and 1959, but it didn't receive full military recognition until February 1964. Just a month before that, Remington put in on the store shelves as a commercial cartridge.

The Remington 222 Magnum and 223 cases are similar in appearance but they're not interchangeable. The 223 is a bit shorter, and care must be exercised that a 223 is not fired in a 222 Magnum chamber. The case could rupture and cause injury.

I think the 223 works best with 55-grain bullets. They are better wind buckers than lighter weights and can attain muzzle velocities of 3300 fps or a bit more.

Speer Reloading Manual No. 11 advises that shooters using 5.56mm military ammo in standard 223 rifles should have their chambers throated to the military configuration.

As long as the military is associated with the 223, there will be an abundant supply of GI cases. This assures the 223 Remington a long life, but the 223's accuracy, as a 275-yard varmint cartridge, will carry on through the years no matter what the military does.

22-250 Remington

The 22-250 is simply a 250-3000 Savage case necked down to 224. It wouldn't surprise me to learn that some experimenter tried this shortly after the Savage cartridge was announced during World War I days. But there's no proof of that at the moment. However, there is no doubt that in the mid-'30s a number of the more advanced guncranks of the era were working on their own versions of this cartridge. The list included — but probably was not limited to — Harvey Donaldson of later 219 Wasp fame, Jerry Gebby, J. Bushnell Smith, and Grosvenor Wotkyns. Indications are that their cases

differed mainly in shoulder angle — an item which seemed to be a big factor in the minds of wildcatters back then. One of these men, Gebby, copyrighted the name "Varminter" for his version, and it became by far the most popular. Doubtless the name helped. It seemed perfectly descriptive of this super accurate, long range chuck buster.

The 22-250 was the mainstay of the benchrest line for years, and why it took so long for it to become a commercial cartridge remains a mystery. Browning offered factory 22-250 rifles before Remington standardized the cartridge in 1967, Remington offered the 22-250 in the Model 700 series. Since that moment, the 22-250 has had little competition in the long range varmint realm. The new 224 and 6mm PPC cartridges (Pindell-Palmisano Cartridge) are dominating the benchrest line currently, but the 22-250 still stands tallest in the back pastures.

From decades of 22-250 experience, both on the range and in the hayfields, I'd say either the 53 or 55-grain spitzer is the top bullet choice. Muzzle velocities can hit 3800 fps with either bullet. Good varmint accuracy can be had with such loads, but I obtained tighter groups with 52-grain bullets held down to the 3600 fps level. The 22-250 is quite capable of shoving the lightweight 40/45-grain bullets at velocities of 4000 fps, but these loads are rarely practical. Most of these lightweight bullets aren't constructed for super high velocities. I call them Hornet bullets, and they should be kept well below 3400 fps. The jackets will occasionally strip off if you push them too fast. In cases the size of the 22-250, heavier bullets do a better job. That's worth remembering.

220 Swift

When Winchester brought out the 220 Swift in their Model 54 in 1935, little did they realize they had turned the proverbial bull loose in a china shop. With over 4000 fps muzzle velocity, the Swift should have been received with shouts of joy by the varmint hunting clan. It probably was at first, but things got out of hand. The Swift soon started getting bad publicity. It was accused of being a barrel burner and of giving erratic pressures. Case stretching and neck thickening were other problems of the violent Swift. Eventually, such criticisms took their toll. The Swift's popularity began to decline and it finally sank into a moribund stage. Ruger tried to revive it by chambering the M-77 heavy barrel for it in the mid-1970s and later chambering the No. 1 Single Shot heavy barrel for it. But it never gained much popularity.

The Swift eroded throats and thickened necks because most users pushed the cartridge to the limit. From what I can gather, early Swift owners went all

Nick Sisley displays a double handful of chucks taken at long range in northern Pennsylvania with his Leupold-scoped 25-06 Ruger.

out for those top velocities, and they generated extreme pressures. This can happen with any cartridge when hot loads are used. Dropping the velocity a few hundred foot seconds will stop the Swift from eroding throats and stretching cases unacceptably. Reducing the velocity will not noticeably cut back on the Swift's effectiveness at ranges up to 350 yards when 55-grain bullets are used. I have made numerous 400-yard kills with the Swift. In my estimation, the 220 Swift is the standard that other 224 varmint cartridges should be measured by.

225 Winchester

The 225 Winchester has departed from the varmint hunting scene, but it still deserves a bit of recognition. If nothing else, it's the replacement cartridge Winchester came out with after discontinuing the 220 Swift in 1964. It never had the Swift's velocity, but it's only a hair below the Remington 22-250, and that's fast company. Velocities with 50-grain bullets will touch the 3600 fps mark, and they are only slightly lower when bullet weight is stepped up to 55 grains.

The 225 has a lot of potential, but it came along in an era that was bustling with cartridge development activity, a lot of it in the 224-caliber field. Between 1955 and 1964, over 25 new rifle and pistol cartridges were introduced. The Winchester 225 made its entrance when a lot of other participants were on stage. It's a semi-rimless cartridge that is ideal for single shot rifles, but it never reached that stage of factory development. Despite its qualities, the 225 was simply ignored.

224 Weatherby Magnum

Weatherby introduced the 224 Magnum in 1963. I have always felt the Weatherby people believed the 220 Swift was heading into the twilight and their 224 Magnum would be its replacement. The 224 Weatherby doesn't measure up to the Swift in every category, but it will run shoulder to shoulder

with the Winchester 225, which replaced the Swift. I like the 224 Magnum, but its cases are not readily available. I have never felt the belted head was needed, but it does fit in with Weatherby's other belted head magnums.

I use only 55-grain bullets in this case, with velocities running between 3550 and 3650 fps. Weatherby rifles are known for their "freebore" or long throat, and several reloading manuals claim that seating the bullet farther out will enhance accuracy. The 224 Weatherby Magnum is not a Swift, but it's close enough to suit me.

243 Winchester

The 243 Winchester is always thought of as a combination cartridge, which means it is suitable for either varmints or the smaller big game species. The late Warren Page, longtime shooting editor for *Field & Stream* magazine, sang the praises of the 243 as a true combination cartridge. His 240 Page Pooper was the forerunner of the 243, which shows that Page had considerable experience with the 243 caliber.

Bullet weights from 70 to 87 grains are best for varmint hunting with the 243, as they tend to fragment on impact. I prefer the 75-grain hollow point bullet for shots up to 350 yards. Beyond that, I stick with the 90 and 100-grain spitzer slugs. The 75-grain bullet can hit 3450 pfs at the muzzle, and a 90-grain slug will churn out a muzzle velocity of 3200 fps.

Bob Wise took this 14-lb. chuck with his M700 243 and Speer 80-gr. handloads.

6mm Remington

The 6mm Remington was originally the 244 Remington, and I have explained that the 1 in 12-inch twist of the 244 failed to reliably stabilize bullet weights above 90 grains. It was reintroduced in 1963 as the 6mm Remington in rifles carrying a 1 in 9 twist. Case dimensions of the 244 and 6mm are identical, and there is no real difference between the 244 and the 6mm. The faster twist in the 6mm stabilizes the 100/105-grain bullet weights.

Research I have done on the Remington 244 indicates it was designed specifically as a varmint cartridge. The 1 in 12 twist was sufficient for varmint bullets up to and including 90 grains. All the fuss was over the 100 and 105-grain weights, and I never found either bullet weight to be as inaccurate in the slow twist as some gunwriters claimed. However, since the change to a faster twist, the 6mm Remington has closed the gap between it and the 243 Winchester. The 6mm Remington is now a common sight in the Pennsylvania deer woods.

The 6mm Remington is ballistically superior to the Winchester 243, but not enough make an issue over. I think it does a better job in the pasture fields with 80 to 90-grain spitzer bullets. I hold velocities with the 80-grain Speer to about 3400 fps, and bump the 3200 fps mark with the 87-grain Hornady spire point.

240 Weatherby Magnum

Some day I am going to assemble a heavy barrel single shot varmint rifle chambered for the 240 Weatherby Magnum cartridge. This 240's varmint shooting potential is grossly overlooked by the vast majority of varmint hunters. Years back, I asked Weatherby to bring out a heavy barrel single shot 240 Magnum with a super trigger but, at that time, they were interested only in building conventional hunting rifles.

Critics of the 240 Weatherby Magnum say it doesn't offer much more than either the 6mm Remington or 243 Winchester. I don't agree. The 240 Weatherby Magnum is capable of significantly higher velocities with varmint-type bullets. Hornady lists a sizzling 3500 fps for their 87-grain bullet with certain brands of powder. This is several hundred foot seconds faster than the Remington and Winchester 6mm cartridges. This makes the 240 Magnum a better choice if shots often run to 400 yards or more.

250-300 Savage

In 1915, Charles Newton designed a 25-caliber case which was marketed by the Savage Arms Co. In his mind, it was deer and antelope cartridge, and

to make it suitable for that type of game he apparently preferred a 100-grain bullet. But Savage dropped bullet weight to 87-grains to get 3000 fps and the advertising value of that impressive velocity. Hence the 250-3000 was offered as much as a varmint cartridge as a deer and antelope creation.

For some reason, the 250-3000 nowadays is usually thought of in terms of a deer cartridge. Although it was chambered in a several factory makes and models of bolt action rifles and got a fair share of attention from custom rifle builders, the 250-3000 saw little use in the varmint realm. The 250's versatility should have made it as popular with the varmint hunting buff as with the deer hunter. The advent of the 6mm's killed the 250-3000's chances of becoming a truly recognized varmint load, but bullets weights running from 60 to 87 grains are superlative long range varmint killers from a heavy bolt action. The 3200 fps muzzle velocity of the 75-grain hollow point will warm the heart of the most demanding long range chuck hunter and, when winds are bending the clover stalks, the 87-grain bullet at 3100 fps with today's powders will hold a steady course. Believe me, the old 250-3000 Savage is a lot more than just a deer cartridge.

257 Roberts

The 257 Robers is best known in Pennsylvania as a deer stopper. Out West, many antelope and mule deer hunters appreciated the brisk velocity and flat trajectory the 257 offered. When Remington standardized the 25 Roberts in 1934, and changed the name to 257 Roberts to avoid confusion with the older version, it was recognized immediately as a dual-purpose cartridge. During the first few decades of its life, it was a popular sporting cartridge, one often plugged by Jack O'Connor and Colonel Whelen. The 257's versatility and higher velocities with the same weight bullets gave it a strong edge over the Savage 250-3000.

I have always felt the 257 is a bit large for chuck hunting, but it's right at home on the larger varmint type animals such as coyotes and foxes. It will easily generate 3200 fps with an 87-grain slug, which makes it more than adequate for 300-yard shots. The 3000 fps velocity of the 100-grain spitzer bullet will be accurate for another 100 yards over the 87-grain slug.

25-06 Remington

The Remington 25-06 started as the 25 Niedner based on the 30-06 case, went through a long period of experimenting with various shoulder angles and improved versions, but finally received factory recognition from Remington in 1969. I had a long association with this 257-caliber cartridge in

the form of a 25 Niedner Improved, which is created by cutting a sharper shoulder angle in the chamber. This allows the shoulder to be pushed forward and permits a grain or two more powder to be used. At the time, I though this was a significant improvement but, after shooting the factory 25-06, which retains the standard 17½-degree shoulder angle of the 30-06, I have changed my mind. Any gain from the sharp shoulder is more psychological than real.

The 25-06's top velocities are 100 to 300 foot seconds faster than the 257 Roberts'. Varmint hunters should develop loads with the 87 and 100-grain bullet weights. I came up with a 75-grain load that works fine on still days, but the heavier bullets are not as susceptible to wind. I occasionally use a 25-06 Ruger No. 1 heavy barrel for varmints, and I am sticking with the 100-grain spitzers for shots that stretch beyond 350 yards.

The 25-06 Remington has kept the 25-caliber cartridge alive since 1969. the 6mm's dominated the scene until deer hunters realized the 117/120-grain 257 bullets were more efficient at long ranges than were the 90 to 105-grain 6mm's, and also offered more energy. Now, varmint hunters are just as aware that the 100-grain 257 bullet is a lot more dependable beyond 350 yards than any 224 bullet. The Remington 25-06 should enjoy a long period of popularity in the varmint-hunting ranks.

257 Weatherby Magnum

The 257 Weatherby Magnum came to life when Roy Weatherby shortened a 300 H&H case, squeezed the neck down to 257 caliber, and put his famous double radius on the shoulder. In other words, the shoulder angle begins with a curve (radius) — not a sharp angle as on most cases — and the neck itself begins with a gentle curve.

The 257 Weatherby Mag has more case capacity than the 25-06, so it is more powerful and will outdo the 25-06's top velocities by at least 200 feet per second. From a long range varmint hunter's viewpoint, the 257 Weatherby Magnum could be the ultimate. It does a super job with the 87-grain bullet when velocities run 3700 to 3800 fps. At such speeds the 87-grain follows a very flat path at any hunting distance.

Personal Experiences With Varmint Cartridges

A 17-CALIBER CARTRIDGE came on the varmint hunting scene around 1969/70 when Harrington & Richardson brought out their version of a 17-223 in the H&R Model 317 Ultra Wildcat rifle. Cases were made by necking down 223 cases to accept 17-caliber bullets. No other modifications were necessary. In 1971, Remington standardized the 17 caliber and introduced it in their Model 700 BDL bolt action rifle.

The 17 caliber started as a wildcat in a variety of forms. A cartridge called the 17-30 Carbine (17 Pee Wee) gets credit from some writers as being the first on the scene, though P.O. Ackley had a 17 caliber based on the Bee case about 1944. The 17-30 Carbine is the military case necked down to 17 caliber. Several 17s have been built on the Remington 221 Fireball case, and the 222 has been necked down to a 17 caliber. Even the 22-250 case was necked down to 17 and called, of all things, the 17 Flintstone Super Eyebunger. This cartridge is claimed to have had a muzzle velocity of over 4400 fps with a 25-grain slug.

17 Remington

For the most part, Remington's commercial 17 caliber sounded the death knell for the wildcat versions. Some of these speedsters used bullets as light as 20 grains. Not many manufacturers offer 17-caliber bullets at this time, but they are available from at least Hornady and Barnes in 25-grain weight.

The 17 Remington is potent. In fact, that's the trademark of the tiny 25-grain bullet. It's so fragile that it seldom exits on animals the size of woodchucks and foxes. Any varmint shooter who has used a 17 is familiar with its resounding "kerplunk" echo when the bullet hits. One writer referred to the 17's impact sound as a "gazorp." It's very destructive, and is not a good hunting cartridge if saving meat is important.

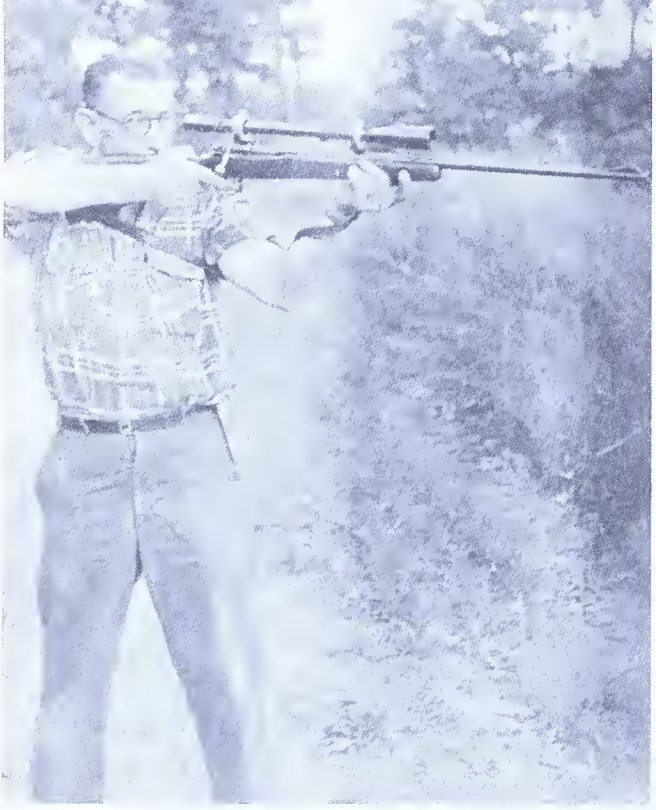
The 17 has high velocity — better than 4000 fps can be attained — but it's a fairly short range cartridge because the tiny 25-grain bullet is susceptible to cross winds. I'm convinced that 250 yards is about its maximum effective range, and I hold my field shots to under 200 yards when the clover leaves are waving.

The fragile lightweight bullet creates a massive amount of hydraulic shock. I have made instant kills when the bullet was only close to a vital area. I recall a 140-yard shot at a chuck that was lying on the trunk of a fallen chestnut tree. When the Model 700 Remington cracked, the chuck never moved. My hunting partner said I had overshot, even though a thudding "gersop" drifted through the evening air. I had learned from hunting with the H&R 17-223 how potent the 25-grain bullet is, so when my partner suggested shooting again, I hesitated. I was convinced the chuck was dead. He claimed if the shot had hit the chuck it would have rolled off the fallen tree trunk, and that did sound reasonable. Nevertheless, I didn't shoot again.

When fifteen minutes passed and the chuck remained motionless, we cautiously moved across the field. By the time we had gone 75 yards, it was obvious the chuck was dead. My bullet had hit very close to the end of the ribcage, angling toward the opposite shoulder. The bullet did not exit, but had literally exploded. It was an instant kill, and I'm sure the chuck never moved a muscle after being hit. This shot and a dozen other similar field episodes have convinced me the 17-caliber cartridge is much overlooked by the varmint hunting clan. The fact that the tiny bullet fragments upon impact, which reduces the chances of dangerous ricochets, makes the 17 ideal for hunting in congested areas.

22 Hornet

Over the years, I made a number of super shots with the 22 Hornet. One shot that I made with a Model 70 Winchester Hornet still stands out in my mind. Not because it was extra long, but because it was extra difficult. The chuck's den was under a lone apple tree in a pasture field that had once been an orchard. Due to numerous buildings on this farm, the shot had to be taken from a ridge some 160 yards from the tree. The chuck's den was on the opposite side of the tree, but there was a narrow slit through the base of the aging tree. Weeds made it impossible to see on either side of the tree, which meant the bullet would have to go through the 4x8-inch opening. The farmer explained that the shot had to be taken the instant the chuck emerged from its den as that would be the only time it would be visible.



Helen's late father, Darrel Nulph, taking a shot at a chuck with my 222 M722, in 1953. I can't remember if he connected on this shot or not, but he had his share of hits.

The owner assured me it was an impossible shot, and that the tree had at least a quarter-pound of bullets in it from others who had tried. All of this shooting had made the chuck extremely cautious. I intended to come back the next evening with a battered Model 54 Winchester 220 Swift I had recently purchased, but when the chuck's head suddenly became visible through the hole, the farmer insisted I try a shot with the Hornet. There was a thudding sound when the bullet hit, and the farmer said the old tree was now one slug heavier. We walked over to the tree, and my host began looking for a fresh bullet hole. I didn't see any sign of the chuck when I looked around the tree, but I did see specks of blood on the dirt pile. Moments later we were examining a 13½-pound chuck that had been hit in the back of the head. That was probably the best shot I made with a Hornet.

218 Bee

My field experiences with the 218 Bee run on the same track as those with the Hornet. Both cartridges fall into the 200-yard category, and I see little difference between the two, though I made one shot with a Model 43 Winchester that almost made me think the Bee was vastly superior to the Hornet.

A heavy rainstorm had forced me to take refuge with the landowner in his wagon shed. While the rain rattled on the tin roof, I gave him some background on the 218 Bee and also spun a few yarns about several super shots I had made with this rifle. I didn't realize I was painting myself into a corner. An unused hog-feeding shed some 225 yards distant had a special attraction for some reason, and as I glassed the area around it, I spied a chuck coming out from under the shed. The farmer took a long look through my binoculars and asked me to shoot. I wasn't too anxious to tackle a 200-yard plus shot with a Bee, but I couldn't back down after telling him about my more vivid shooting successes with it.

I had to shoot from a wooden fence, so he gave me an empty feed sack to spread on the ground. I slipped into the prone position and rested the Model 43 on the bottom board of a cow gate. The chuck looked mighty dim in the inexpensive 6x Weaver Model G scope, but I did the best I could to hold the reticle just above the chuck's head while pulling the trigger. The chuck disappeared when the rifle cracked, and my farmer friend kidded me about all the good shots I had told him about. But, I always check every shot, and a cool wave of relief went over me when he pulled a fat chuck from under the ramshackle building.

222 Remington

I've probably killed more chucks, crows, and foxes with the 222 Remington cartridge than all other varmint cartridges put together. For nearly seven years, I used it almost exclusively over the western and northern sections of Pennsylvania. I owned and used other outfits, but I always referred to the Remington 222 as my bread and butter varmint cartridge.

Even as I glanced over some old hunting records, most of the 222 Remington shots were beyond my recall. The most vivid episode in my mind was my first chuck encounter with a Model 722 Remington topped with a one-inch Unertl target scope. It's vivid because I fired three times before I connected. To make matters worse, the distance was less than 200 yards.

I had spotted several chucks across a valley. One was sitting on the battered remains of an actual log house. Only a few rotting logs remained, but I had a historical interest in this decaying antique, because it was a genuine relic. This particular night when I was hunting for the first time with my new varmint outfit, I discovered that the old remains housed several woodchucks.

I was totally unfamiliar with the 222 cartridge then and I badly overestimated the distance to the chuck. With the rifle zeroed in for 200 yards, I felt it would require an inch or two of holdover. My hunting buddy, another Hornet fan, agreed. Two shots later, the chuck was still resting comfortably on his perch, and it became obvious that my bullets were passing him and hitting far beyond. My third shot was a dead on hold that turned the tables in my favor. It was the first of countless kills for me with this impressive little cartridge.

223 Remington

As far as I'm concerned, the Remington 223 cartridge is in the same harness with the Remington 222 Magnum; that is, they're ballistic twins. I

Helen shooting our first 220 Swift. It was undoubtedly our ugliest chuck rifle ever — and perhaps our deadliest.

tested several rifles chambered for the 223, but my best experience came from a four-day 1982 prairie dog hunt in South Dakota. I used the now discontinued Smith & Wesson Model 1500 heavy barrel and a Model No. 1 Ruger heavy barrel for hundreds of kills. The wind was a major problem for all of the cartridges four of us were using, and even though the 223 Remington cartridge normally has a 275 to 300-yard potential, I collected most of my dogs under 200 yards on that trip.

Winchester 220 Swift

This old-timer has always had a special place in my affections. I have defended it time and again, and I still say it is a top 350-yard varmint cartridge. Helen and I made too many 275 to 350-yard shots to think otherwise. She has shot more chucks with the Swift than I have, and I'm still being reminded of an incident where I put my foot in my mouth. In other words, I started talking before I started thinking.

Flaig's in Millvale, Pa., had installed a 220 Swift Ace barrel in a Mauser action for me, and stockmaker Randall Fredericks of Kittanning, Pa., bedded the outfit in a beat-up Mauser stock for early test firing. The test outfit was topped with a 10x Unertl Ultra Varmint scope. This particular evening, Helen and I were sitting along a fencerow that overlooked a 400-yard long field. We had the Swift zeroed for about 300 yards. A chuck offered a shot at about that distance, and Helen dispatched him with a neat head shot. Minutes later, a second chuck raised up a few yards closer, and he met the same fate, in the same manner. Rain was moving our way from the horizon, and we were getting ready to leave when a third chuck came out of a den 242 steps away. He joined his brethren an instant after Helen's

sensitive finger touched the set trigger and released a 55-grain spitzer.

As we were carrying the chucks from the field, I reflected, "You know, with a little more practice, you could become a pretty good shot with this new outfit."

"What!" Helen gasped. "I just made three straight head shots at long range. How much better do you think I can get?"

As I look back on that evening, it was a preposterous remark to have made. Helen's shooting had been uncanny, and she had made the proper sight corrections for the various distances. How much more could she learn? The ensuing summers proved that Helen and the new Swift made an unbeatable team. Many years later, I'm still living with my famous statement, and I often wish my thoughtless observation had died as quickly as the three chucks.

22-250 Remington

A chuck hunting friend used to constantly berate the Remington 22-250 cartridge. He was a 6mm fan and, in his opinion, the 22-250 was only a small step above the Remington 222. It might reach 275 yards on a still day, but its bullets were too light for long range shooting, he claimed. He believed it took a bullet weight of 75-grains and above to stay on course much beyond 250 yards. The 22-250 just couldn't be a long range cartridge. I argued that he was as wet as the bottom of a lily pad, but nothing could change his mind. A week later found us in a long, narrow pasture field. Naturally, he had a Model 70 Winchester 243, and I was carrying a Ruger heavy barrel 22-250 topped with a 6-18x Redfield.

He had drawn the short straw and had first shot privileges. When the chance came, his 90-grain slug lifted a cloud of dust from a dirt pile some 350 yards distant. The chuck lost no time in diving underground. Before my talkative pal could finish his technical alibi as why he had missed, the chuck was back on the dirt pile. It was my turn to shoot, and I centered the Redfield's crosswire high on the chuck's ribcage and sent a 52-grain match bullet on its way. The chuck disappeared instantly, and my friend gleefully called it a clean miss. But he was wrong. And I've never let him forget it.

225 Winchester

Winchester introduced the 225 as a replacement for the discontinued 220 Swift, but it never caught on. I used a Model 70 heavy barrel 225 in the chuck fields for several summers. Helen and I made numerous kills up to 300 yards,

which certainly qualified the 225 as a genuine varmint cartridge. Being a semi-rimmed cartridge makes it more suitable for single shot outfits, and that's the kind of 225 I intend to have someday.

224 Weatherby Magnum

"Watch you don't scratch the stock," I warned as Helen slid the new Weatherby Mark V 224 Varmintmaster over the bottom rail in a dying stake and rider fence. She gave me a nasty look, and I offered no further advice on gun care. I turned my attention to a chuck that was nonchalantly eating at the end of the field. As I kept the binoculars glued on the ranging chuck, Helen followed it through the 3-9x Weatherby scope that boasted Weatherby's "Lumi-Plex" reticle. I lowered the binoculars just as the Varmintmaster cracked.

"I didn't hear the bullet hit," I commented after explaining I hadn't been watching when she shot.

"Well, it did," she said sarcastically. She was right.

243 Winchester

In mid-1957, I latched on to a 243 Model 70 heavy barrel Winchester varmint outfit that had less than two boxes of ammo run through it. It just so happened that at that time I was trying to help a farmer get a chuck which had been raiding his tomato patch. The half-acre plot was just over 300 steps from the owner's back porch, and the chuck had a den under a stump at the top side of the patch, which added 30 yards to the shot.

The chuck was incredibly wary. In fact, the farmer claimed he seldom saw it out of the den, but that it would watch for long periods of time with just its head protruding above ground level. Slamming the screen door would make it disappear for hours. I had tried twice to connect with the 222, but both slugs hit the dirt pile.

Shortly after purchasing the 243 Winchester, I loaded a box of ammo with a powder/primer combination that was supposed to give the 87-grain Hornady bullet a muzzle velocity of over 3150 fps. I zeroed it in approximately 3 inches high at 100 yards, and waited for a still evening to visit my farmer friend. It was a perfect evening except for a slight drizzle.

My friend had fixed up a crude shooting table and stool on his back porch with several feed sacks partly filled with sand. All I had to do was to settle into a comfortable shooting position and wait. And wait I did. For over an hour there was no sign of the chuck. As our hopes waned, the sun sank deeper and deeper and the rain continued to drizzle. We were ready to give up

when the chuck's head suddenly appeared at the base of the stump. It was now or never, and I froze the crosswire of the 10x on the chuck's head and released the trigger. My host said the shot hit low as he was sure he'd seen a small cloud of dust after the shot.

As we walked to the stump, we both wondered where the dust had come from. The ground had to be wet from all the rain, but we finally reasoned that the bullet had dug deep enough to hit dry dirt. That wasn't the case at all. The truth is that the bullet centered the chuck's neck and exited from the back. The miniature dust cloud had actually come from the chuck. Its thick fur was filled with dust.

Redfield-scoped heavy barrel 22-250 Ruger has taken many chucks for me over the years. This 13½-pounder was cleanly killed at a bit over 350 yards.

6mm Remington

One evening, Helen, Tom Leete and I were watching several choice sections of chuck county in northern Pennsylvania's Coudersport area. I had a No. 1 Ruger heavy barrel 22-250 with a 10x Unertl Ultra Varmint scope, Tom was carrying 50-caliber Thompson Hawken flintlock with open sights, with which he does exceptionally well on shots up to 125 yards, and Helen was using a Remington 700 BDL 6mm topped with Redfield's 3-12x Ultimate Illuminator. We were watching a series of holes, and one large dirt pile in particular, across a wide valley. When a chuck's head appeared above the big pile of dirt close to 300 yards distant, Helen was nominated to do the shooting. The chuck disappeared when the rifle cracked, and Tom claimed it was a hit. There was no sound of a bullet hitting, so I declared she had overshot the hog, and told them why I thought that.

They double-teamed me, and I was about ready to concede when Tom looked through his famous 6x Bushnell Compact binoculars and said the chuck was on top of the pile. While Helen adjusted into a shooting position, I kept on explaining why I knew she had missed. There was no doubt about her second shot for the chuck lay motionless in full view after the 6mm's echo died in the distance. On the long walk to the hole, I added more comments as

to why I was certain her first shot had missed. When we arrived, Tom's "Jumpin' catfish" told me something was wrong. Friends, you just can't realize how despondent a varmint-hunting expert can feel when he sees one dirt pile, two den holes and two extremely dead chucks. Who was the sage who said, "A still tongue makes a wise head."

240 Weatherby Magnum

Whoever was in the hayfield high on a hilltop off to my left was having a super evening. I have no idea how many shots he fired; I lost count after the seventh report cut through the evening air. Trouble was, I wasn't seeing anything. My curiosity finally got the better of me, and I eased to the top of the hill. It was a chuck hunting buddy, and he was trying to figure out how to connect on a den of chucks over 300 yards distant.

I sat down beside him and he explained his 22-250 was no match for a strong crosswind. When he learned I had a 240 Weatherby Magnum, he asked me to take a shot. Down where I had been, the wind was gusty, but up here on top it was really whipping the clover. I was using factory ammo with 85-grain Nosler bullets, but I had a feeling I still was on the light side bulletwise. When a chuck stretched out on a dirt pile offering a broadside shot, I held on its head, which put the crosswire five inches into the wind from the ribcage, and sent the Nosler down range. Maybe it was luck, but the solid "Whack" more or less solidified my belief that the 240 Weatherby Magnum is one whale of a long range varmint cartridge.

257 Roberts

Right after I began the "Shooter's Corner" for *Game News,* Helen and I were invited to hunt chucks in a northwestern county. One of our hosts had a 257 Roberts on a Mauser action and topped with a 10x Lyman All-American scope. He was explicit about the accuracy of his custom outfit. Most of the day, he related incidents of incredible shooting he'd done with his 257.

Toward evening, the landowner told us about a chuck in a back pasture that had survived a half-dozen shots. The chuck was so wary now, it was almost impossible to get a shot. The elderly farmer literally crawled to the top of a rise and cautiously peeked through the grass. Sliding down to us, he reported the chuck was out about 200 yards away, and that Helen would have to crawl to the top to get into a sitting position. The grass was too high for a prone shot, and the chance was complicated because the 257 owner insisted Helen use his rifle.

Helen and our host eased up the lane in bent over positions. As the farmer raised up to look, the chuck suddenly darted down the hole. The farmer motioned that the hunt was over, and Helen stood up. As the farmer glassed the hole, he reported the chuck's head was visible. Helen scoped it from a standing position.

"We're still not high enough to get a sitting shot, but we can't move," the farmer complained.

"I can hold the crosswire on the chuck's head," Helen replied. "I can even see its eye, and I think I can hit him right from here."

"Can your wife do that? Can she hit a chuck in the head from the offhand position at almost 200 yards?" the 257 owner asked.

"Don't ask me," I answered. "She's the one doing the shooting."

"I'd have to see that to believe it," the Roberts owner said.

Helen locked into the offhand position and fired. I was still below the ridge level and couldn't see where the bullet went, but I thought I heard it hit. The landowner said the shot was low.

"I forgot to tell you the impact would be about an inch low at that distance," the 257's owner told Helen. "If you'd known that you could have held above the eye instead of on it," he said, giving me a big wink.

Another 22-250, Remington's M700 Varmint Special, scoped with a 6-24x Bausch & Lomb. Chuck shown was killed at 304 steps, and a moment after this photo was snapped, I duplicated that shot.

A couple of minutes later, our host extracted a very large dead chuck, and handed it to the 257 owner. After examining it unbelievingly for a full twenty seconds, he said, "The bullet hit just below the eye."

Helen studied the chuck for a few seconds, looked the dumbfounded 257 owner right in the eye and with a straight face said, "Yep, your rifle's shooting low."

25-06 Remington

I shot a lot of chucks with the 25-06 when we still called it the 25-06 Niedner. One evening, I zeroed mine in about 3 inches high at 100 yards. My benchrest was high on an abandoned stripmine spoil pile but, below and to the right of the bench, a pasture field stretched for 500 yards. Every now and then I would get a shot, but the closest hole was well beyond 375 yards.

That particular evening, I was feeling blue as a new road was wiping out my range. In fact, a surveying crew was working directly in back of me. After zeroing in the 25-06, I was packing my gear to leave when a chuck stood up at the far end of the field. I shifted my rifle rest into alignment and centered the crosswire of the 12x Weaver on the chuck's head and fired.

"You missed," said a voice behind me.

When I turned, the surveyor was grinning from ear to ear.

"I heard you shooting, and just thought I'd see what all the fuss was about. I saw you miss the groundhog but that's too far to shoot at a moose."

"I'm going over to check," I said.

He walked out with me, and couldn't believe his eyes when I located the dead chuck. "You're a surveyor," I said. "How far is it from here to the bench?

"I'm not sure, but we'll soon find out."

Ten minutes later, he had a man at the den hole holding the stadia rod while he calculated the distance from the benchrest.

"It's 471 yards," he said, shaking his head in disbelief.

I don't think he believed me when I told him many topnotch woodchuck hunters wouldn't consider that distance a super long shot.

The Benchrest

TO GET THE full accuracy potential from a rifle, it must be fired from a solid rest. It's practically impossible to sight in a rifle by resting it against a tree or on a fencepost. The rifleman should be in a comfortable sitting position, feet flat on the ground and shooting from a benchrest. I'm not saying it's impossible to sight in a rifle from a makeshift table or some other type of support but, after four-plus decades of shooting, I know for a fact nothing beats a sturdy benchrest.

Some shooters feel the construction of a benchrest is just a matter of work, the main features being sturdiness and comfort. While any solid table will suffice, after building a half-dozen benches I know that design and construction spell the difference between a good bench and a mediocre one.

The design of every benchrest I shoot from gets a thorough going over from me, and it's surprising how little thought and effort is put into some of them. Over the years I have seen benchrests made of wood, steel and cinder blocks. They came in all shapes and sizes. Few were comfortable, and most were difficult to shoot from. Surprisingly, some ranges I have fired on didn't have one rest to accommodate the left-handed shooter.

Rigidity is most important. It's advisable to use 5½ foot, 4x4-inch treated locust or cedar posts sunk at least 36 inches into the ground. When buried that deep and tamped in solidly, there is little need to use cement unless it makes you feel better to dump a wheelbarrow load around each post. This leaves 30 inches of post length above ground and, when a 2-inch plank top is installed and covered with a sheet of exterior plywood, total bench height should be about 32 inches.

The leg assembly is stiffened by spiking 2x8-inch planks to the outside of the upper ends of the posts, with several 2x8s spiked crosswise or lengthwise for extra support. The top surface of the bench should be made from 2x6s or

My oldest son Darrel checks a reloaded 223 cartridge before chambering it in the M84 Kimber. He's shooting from the bench inside the shop — which is particularly nice in the winter.

2x8s, spiked to the 2x8 frame. Naturally, the frame will have to be constructed to accommodate the design of the bench top. Just make certain there is ample support for the top planks. When rough construction is finished, cover the top with one piece of 1/2 or 5/8-inch exterior plywood and paint it immediately. A coat of paint each year will keep the bench in perfect condition for many years.

The top of the benchrest should be shaped like a T or U. Either design will accommodate both left and right-handed shooters. Unless a chair or stool is used for a seat, the common practice with the T-type is to use a single plank that passes under the T and rests on two 4x4-inch posts. The bad aspect of such a seat is that it has no provision for adjustment. In some cases, the seat is attached to the benchrest, but this is not advisable. The seat should always be separate from the bench. I like the U-type, where the shooter sits between the two extensions from the bench proper. The biggest advantage with the U-type is that only a single adjustable seat is needed.

My favorite way of building an adjustable seat is to weld a one-inch coarse-thread nut into a two-inch pipe. The pipe should be buried at least 30 inches deep in concrete, with no more than 12 inches of pipe above ground. Weld some type of seat (I used a discarded mowing machine seat) onto a one-inch coarse-thread bolt or bolt stock 12 inches long (I used a one-inch bolt and had a machine shop cut extra threads). Screw the bolt down into the nut, and you have a seat similar to the old piano stool. Normal shooting heights run from 15 to 20 inches, depending on the height of the shooter.

You can remove most of the wobble from this type of seat by using two nuts welded together, or having a machine shop drill and thread a two-inch piece of round bar stock for the seat bolt to screw into. Weld this "long" nut into the pipe. The more threaded area the seat bolt comes in contact with, the

less wobble in the seat. A word to the wise here — keep the bolt and nut well lubricated.

It's wise to experiment with a small stool or chair before installing the pipe in the ground. Placing the seat too far forward or back will make it uncomfortable to use. As a rule of thumb, the pipe should be in the middle of the U and roughly 15 inches back from the main table.

The bench top should be four feet wide and five feet long. On a four-post U-type bench, the U should be 28-inches deep and 16-inches wide. This will allow two 16-inch-wide arms extending back from the main top. You need plenty of room for your shooting arm's elbow.

On a three-post T-type bench top, the rear extension should be 16-inches wide and at least 30-inches in length. Always allow plenty of working and elbow room.

The area around the benchrest should be covered with concrete or limestone chips. There's nothing worse than wading around the bench in several inches of muck and mud. Finally, build some type of rifle rack a few yards behind the bench. This doesn't have to be a monumental expenditure; just something from rough lumber that will hold three or four rifles. Adding several pegs to hang ear protectors on, plus a shelf for muzzleloader components (never keep powder, powder horns, or percussion caps on the bench when shooting black powder guns) will pay for itself many times.

I stick with wood for the benchrest in Pennsylvania, as steel gets bitterly cold in winter and blistering hot in summer. Benchrests made of cinder block supports with three-inch concrete tops tend to come apart from the expansion and contraction caused by Pennsylvania's numerous frosts. The mortar joints fail first, and eventually the entire bench literally comes apart. In fact, frost can play havoc with any benchrest; that's why it's important to sink the supporting posts far below the frost line.

A padded vise for adjusting open sights or changing scopes is a useful addition on a benchrest. I used an inexpensive carpenter's vise for years. It was handy for holding the rifle to square the reticle, set the eye relief or make an open sight adjustment. A vise is really an extra set of hands and, in my case, eliminated thousands of steps back and forth to the gunshop.

Once the benchrest is constructed, the next step is to learn how to shoot from it properly. The old saying, "Practice makes perfect," is not necessarily applicable to benchrest shooting. Practices does not make anyone perfect, unless it's the proper type of practice. This leads me to say that there is a right way and a wrong way to shoot from a benchrest. This might not apply to sighting in the old 30-40 Krag before buck season or burning a few shells with an open-sighted 22 rimfire. The paramount reason for having a benchrest is

to improve considerably your shooting skills. Few hunters ever learn to shoot during the hunting season. There just aren't that many opportunities for most of us to learn how to use our rifles. This is where the benchrest enters the scene.

In the woods and fields, the hunter is normally at a disadvantage. Unknown distances, wind, heat waves, and a lack of rifle support introduce a high percentage of guesswork into every shot. From a solid benchrest, only wind and mirage — heat waves — annoy the hunter, and these can be overcome to some extent. We tend to correlate a kill with good shooting, but that can be far from the truth. A dead deer or woodchuck has little to say; it could have been hit 10 inches from the aiming point. But a target doesn't fall down when hit, and the holes remain indefinitely for the shooter to study. A 5-shot group has plenty to tell the shooter.

To zero in a big game rifle is one thing, but shooting groups to determine a rifle's potential is a vastly different ball game. A big game or even a varmint rifle can be successfully zeroed in from a portable bench, a rolled blanket or a couple sacks of sawdust on top of a folding ironing board. That's one type of shooting. Group shooting requires more rigidity and proper techniques.

One hunter was upset over the fact that I used a benchrest to zero rifles. He announced in a loud and clear voice that he could "kill every buck in the woods if he had all the fancy gear I used." My efforts to explain that I wasn't trying to show him how well I could shoot, but rather how well the rifle would shoot, fell on deaf ears. He tossed a rather low blow when he said, "You're not shooting, buddy, you're just pulling the trigger."

In all our shooting, the human element plays a vital role. That fellow apparently thought that the solid bench totally removed the human element from shooting. That, too, is far from the truth. In fact, proper shooting from a benchrest requires a good bit of skill. It's true the rifle is resting on double supports, but that alone doesn't eliminate the frailties of our nervous systems nor does it compensate for the mental mistakes that make our groups look like miniature shotgun patterns.

Two elements are mandatory: solidity and uniformity. The rifle must be motionless, and each shot must be fired in the same manner as its predecessor. Uniformity is nothing more than repetition, but that is easier said than attained. When the proper technique is learned, it must be practiced over and over until it becomes second nature. Notice I said "proper technique," not just any technique. Believe me, this is not a one-shot affair, and that's not meant to be a pun. It takes time to adapt to the bench, get the right seat height, and place the body in the shooting position that brings out the best in you.

There is some disagreement about the proper sitting stance. Some like to place the body at a 90-degree angle from the bench, but that's an impossible position for me. When I try it, the recoil is absorbed by my arm instead of the shoulder pocket. Some fine shooters strongly advocate not touching the bench with the body, but I also find that uncomfortable.

Normally, I sit at an angle from the line of fire, something between 45 and 90 degrees. Being right-handed, my ribcage just below the right nipple touches the bench. I've seen shooters shake their heads in disbelief when they learned I had no objections to touching the benchrest. Actually, if the bench is strong and immovable, I make rather firm contact. I have tried other techniques, but this method works best for me. I can't establish absolute guidelines on how to shoot from a benchrest, as there are many techniques and methods, but I do know that whatever position gives the best results is the one to use. Few top competitors use exactly the same method.

It's important not to sit in a rigid position. Don't freeze the muscles into a solid mass. I allow my body to sag, so I shoot from a relatively low position but not draped over the bench. I suspect the correct shooting stance depends on each individual, but no matter what position is used, being completely relaxed and comfortable are the two main considerations. The body should sag — some say sog — but in any case the tension in my body is just enough to offset some of the recoil.

There is no given way for holding a rifle, but I like it flat and square on the sandbags. I expect the sandbags to hold the rifle and I want as little body contact as possible, but I am not suggesting the shooter shouldn't have some contact. It's impossible to shoot a heavy recoiling rifle without holding it in a firm grasp. On light recoil bench and varmint outfits, I use a relatively loose hold, with the butt pad making only light contact, if any, with the shoulder. With the more powerful jobs, I pull the buttplate straight back into the shoulder pocket with the shooting hand. I want to emphasize that is how it should be done. The shooting hands does not push or pull sideways; the three fingers of the shooting hand should always pull straight back. However, this is easier said than done, and I believe the majority of shooters push or twist the rifle with the shooting hand. The end result is a canted rifle. Canting a rifle is a serious mistake in the world of competitive benchrest shooting where groups are measured in thousandths of an inch rather than in inches as with varmint and big game rifles. A small cant on the 30-06 won't spare a deer's life, but it can be a serious mistake for a competitor, if all his other shots weren't fired from the same angle. Still, it's best to hold a rifle plumb, I believe. When all these seemingly insignificant shooting errors are eliminated, group sizes begin to shrink.

You can't shoot consistently tight groups until you master the trigger. This applies to all rifles. It's imperative to learn to read or control the trigger, no matter how light the weight of pull. On competitive benchrest rifles, the trigger pull can be as low as two ounces. Some varmint outfits with special triggers can be adjusted to less than a pound. To a big game hunter, this type of trigger is normally classified as a hair trigger or set trigger. Many believe such a trigger is so light nothing can be done to control it. But no matter how a lightweight trigger is classified, it still has to be controlled. There are a half-dozen ways of doing this, and each shooter has to work out the formula that produces the best results for him. In any case, with exceptionally lightweight trigger pulls on heavyweight varmint rifles or competitive jobs, the shooting hand will not make firm contact with the pistol grip or thumbhole. The only pressure will come from the index finger moving straight back against the trigger.

The procedure is basically the same for shooting big game cartridges, but the approach is different. No longer can the rifle be allowed to rest on the bags of its own weight, with little or no body contact. If a 7mm Magnum or 30-06 is fired with the same hold as a competitive outfit, chances are good the rifle will react like an untamed mustang, and there is a distinct possibility that the shooter will get whacked above the eye with the rear end of the scope tube. Common sense must prevail, and common sense tells us that you can't shoot a 7-pound big game rifle with the same relaxed position used with an 11-pound varmint outfit. You can't keep it from moving under recoil, but you can keep it under control.

I shoot the larger cartridges from a higher position. This puts my shoulder's pocket in direct alignment with the backward thrust of the rifle. Also, I allow my body to pivot somewhat at the hips, much as a catcher allows his glove to move backward when the ball strikes it. This helps absorb some of the recoil. If you tense up and the muscles are rigid, the rifle will hit it a sharp blow and then bounce off like a rubber ball, and every fiber in the body will tingle from recoil. The whole idea is to absorb the recoil without undue punishment. Throw a baseball against a brick wall and it will fly back. Throw it just as hard against a board hanging from a clothesline, and it won't come back nearly as far. The brick wall did not move backward when struck, but the board did. A good bit of the ball's forward energy was used to push the board backward. If the shoulder is like a brick wall, the recoil won't be any greater from a mathematical standpoint, but the shooter will think it is. I hold the hard kicking jobs tightly against the shoulder, with my cheek bearing reasonably firmly against the stock comb. However, I'm relaxed through the midsection, which allows the top half of my body to pivot to

some extent. I want to emphasize that I maintain full control of the hard kicking rifle.

If you are going to do a lot of shooting, the normal pad on a shooting jacket or vest is not adequate. There's no shame in installing some extra padding. For many years I have used a thick six-inch-square piece of carpet sewed behind the conventional pad when I do extensive testing with the larger magnum shells. This setup not only keeps the butt pad from digging hard into the shoulder pocket, but also spreads the recoil over a larger area of the shoulder. I know this works because I have fired 140 rounds from a 378 Weatherby Magnum over a two-day period without suffering anything more than a little soreness in the shoulder muscles.

My association with the so-called sissy bag has been limited. Basically, this is a small sack of sand that is placed between the butt and the shoulder. The advantage of the sissy bag is that it seems to add weight to the rifle. In other words, if the bag weighs four pounds, that's additional weight the recoil has to move, which in a sense is added weight. Also, the bag will absorb some of the recoil, since the sand will compress as the rifle moves backward when it is fired.

U-shaped bench can be used by either right-hander or southpaw. It helps if the seat is adjustable for height.

I'm not opposed to using such a sandbag because it's called a sissy bag. No one needs be ashamed of using extra protection to prevent shoulder or muscle punishment. Apparently, I don't bruise easily, as I can't recall having bruises or blue marks from recoil, but I do occasionally notice stiffness and soreness, which indicates that the muscles are being subjected to excessive recoil. The sissy bag also keeps the face well back on the stock. This helps prevent getting struck with the scope, but I find it difficult to shoot with only a partial field of view.

Heavy recoil rifles are not for every hunter, nor are they needed for medium-size or even many species of large game. The 300 Magnum, with its heavy recoil, is not my idea of a white-tailed deer rifle unless long shots are the rule. The average big magnum owner doesn't shoot enough to get used to it. While the magnum cartridge definitely has a place in the hunting realm, it should be used primarily for animals that require heavy bullets producing great amounts of kinetic energy. Few shooters and hunters are indifferent to recoil, and only a minority of shooters can fire the magnums without thinking about recoil.

After a shooter has been jolted hard several times by the backward thrust of a magnum, he has less desire to keep on shooting. When he loses the first round to recoil, it's tough to forget it. In most cases, it won't be forgotten, and an insidious fear of his rifle will develop. That's the end of the road, as far as I'm concerned. No one, myself included, enjoys being pummeled by heavy recoil; it isn't conducive to good shooting. Be wise and step down to a smaller cartridge that is easier to shoot.

The best approach to shooting from the benchrest is to first get comfortable, keeping both feet flat on the ground. I have already explained how the body should be angled slightly toward the front right-hand corner of the bench for right-handers. Whether you touch the bench with the ribcage or not is purely a personal matter. The whole idea is to be seated firmly on the bench stool, with the rifle high enough to keep the body in a semi-upright position. I can't give an exact height for the front sandbag, as that depends upon the height of the shooter. The rear bag has to be adjusted accordingly to level the rifle.

I shoot a heavy recoiling rifle from a much higher position than a heavy barrel varmint model, because that seems to reduce recoil. However, I can shoot tighter groups from a lower position. When the body is upright and the rifle is on high sandbags, there is far more wobble and shakiness. The more sagged the body is, the more stable the shooting position. It's a matter of finding the shooting position which is best suited for your needs.

Breath control is important, as is developing a rhythm to the shooting. I

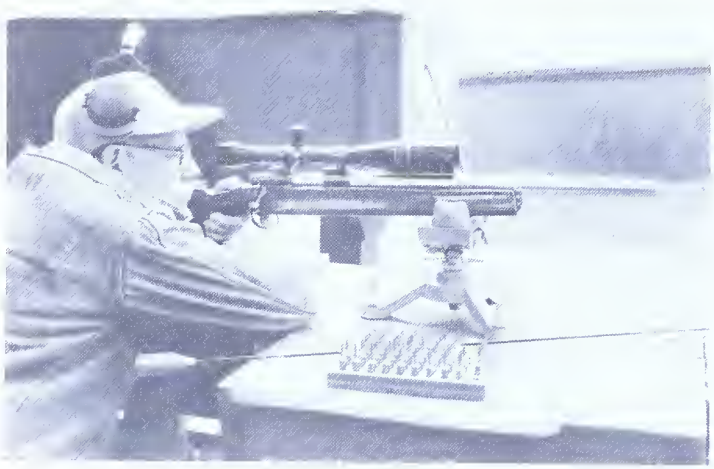
don't waste a lot of time aiming. The longer the aiming time, the more nervous the body becomes. By the time I take a deep breath and exhale part of it, I have the reticle on the aiming point. From that time on, my time is spent concentrating on the hold while pulling the trigger. This I try to do in five to seven seconds. I never allow my heart to start pounding nor do I hold my breath until my lungs want to burst. When any shooter holds his breath for a considerable length of time, these two things happen. So far as I'm concerned, shooting under those conditions is simply wasting ammo.

How quickly you should get off a string of three or five shots depends a good bit on the cartridge and type of rifle being used. A light barrel will heat up much faster than a heavier one. For big game rifles, the 3-shot string is sufficient. Three shots, even in a super magnum, won't overheat the barrel. Don't fire another group until the barrel has cooled to a point of just being warm. On varmint rifles, I fire longer strings, but the 3-shot group is usually adequate. The longer the string, the more pressure on the shooter. Unless you are geared to competitive shooting, 10-shot groups will not prove anything. With the 3-shot group, there is less time for the nervous system to overreact. Also, it doesn't require a long waiting period for the rifle to cool.

If you're really a perfectionist, allow the rifle to cool after each shot, and this will give a true picture of how the rifle shoots from a cold barrel. This type of shooting can be important to a varmint buff, who is interested in the precise placement of his first shot at long range, and to pronghorn or other big game hunters who shoot at greater distances than most of us.

Finally, don't expect miracles. I'm not being demeaning when I say that most big game hunters will not fire spectacular groups from the benchrest. There are two basic reasons for this: the big game rifle is not a competitive outfit, and the average big game hunter is not a competitive-type shooter. I can drive a car, but not in the Daytona 500. Instead of worrying about regularly breaking the magic inch mark at 100 yards, be satisfied if your groups are reasonably tight and consisent. If your basic 3-shot group averages around the 2-inch mark or a little bigger, don't panic; that's not bad shooting with a big game rifle. As time goes on and you become more proficient at the bench, the groups will probably start to shrink. Even if they don't, you'll always have a good feeling inside from knowing you can hit the bottom of a condensed milk can at 100 yards from a rest.

I want to reiterate that you will probably never learn to shoot in the woods, but you can from a benchrest. I'm aware that, as the fellow pointed out, you won't have all that fancy equipment in the woods during big game season. But I am also aware that much of what is learned at the bench will carry over into the woods. Leaning against a thin swaying beech in a snow



Lincoln Longstaff starts to settle in at his bench, a T-type. Rifle is a 6mm PPC built on 40X Remington action glued into McMillen fiberglass stock. Trigger is a 2-oz. Hart, scope a 36x Leupold. It shoots.

squall and aiming at a half-hidden buck 90 yards away is a far cry from sitting firmly on the bench seat with both feet flat on the ground and a sharp black square on the white target board. On the other hand, the same breath control and trigger pull used at the benchrest can be used in the December woods.

One major benefit of benchrest shooting is concentration. We learn in a hurry at the bench that we must concentrate on the aiming picture while pulling the trigger. This concentration, or self-control, slows us down. We are not so apt to fire too quickly. More than one buck has escaped because the hunter fired an instant before the reticle hit the ribcage. Taking an extra second or two can mean the difference between a hit and a miss, and this type of self-control is a direct product of the benchrest.

Maybe your rifle will never cut the inch mark at 100 yards. Maybe you will never reach that degree of precision with any rifle. Still, the benchrest makes you compete with yourself. When groups sizes drop from three-plus inches to less than two, it's because you became engaged in a conflict with yourself. How much further the groups will drop is entirely up to your competitive spirit. Just the desire to do better is proof the benchrest benefitted you.

When the winds of winter finally draw a curtain around the shooting bench, you will feel a strong desire to prove your shooting skills in the woods. No longer will you have doubts about scoring when the moment of truth arrives; it becomes simply a matter of getting a shot. You have already learned what you and your rifle can do as a team, and that's half the battle.

Rifle Sight In

"WHY WOULD ANYONE allow another person to sight in his deer rifle," a shooting pal asked. "I can't imagine trusting something as critical as that to someone else. That's not for me; I want to do stuff like that for myself."

"You know, it didn't make a lot of sense to me when you paid to have a new water heater installed." I tossed back. "Those kinds of things I want to do for myself."

"I paid to have it done by someone who knew how. Not everyone knows how to install a hot water heater properly."

"You just answered the first question you asked me," I told him. "It's the same with rifles as it is with water heaters or whatever. Not everyone knows how to zero in a rifle properly."

During the years I operated a scope mounting/sight-in shop, that question was tossed at me literally dozens of times. Mostly it came from experienced shooters, men who were familiar with rifles and scopes. They felt every hunter should do his own. I'm the first to agree. But countless hunters do not have sufficient experience to know how to correct many sight-in problems. That's understandable, for they don't do a lot of shooting. When they encounter even a simple problem, they don't know what to do. Sometimes sighting in a rifle is just shooting and making a few minor sight adjustments, but from many years of experience, I have learned that is the exception and not the rule. Everything has to be just right for an inexperienced shooter to easily zero in a rifle. There is a hidden problem here: the inexperienced shooter doesn't know when everything is right. I ran into this countless times.

For instance, a sloppy drilling job puts the scope off-center. The new shooter runs out of windage adjustments before his bullets are in the bullseye. In all fairness to the shooter, how in the world would he know what

is wrong? Everything looks fine and, even if he removed the scope and mount bases, the answer wouldn't jump out at him. Only an experienced shooter or gunsmith might be able to detect the off-center holes. They can be as little as a few thousandths of an inch from the centerline of the action. This small error might not affect all scopes, but this happens to be one of the most common problems in zeroing in a rifle.

I agree that every hunter should check his sighting arrangement, and I encourage all hunters to at least attempt to sight in their rifles. However, it's no shame to get professional help. After all the mounting and scope adjusting problems are eliminated, you might want to do the rest, if you have a safe place to shoot.

Before you take up the task of sighting in your rifle, you should first understand why you are doing it. There's more to sighting in a rifle than just putting a shot or two in the bullseye.

Zeroing in a rifle is a teaching session. During the sight in the shooter will become familiar with his rifle; he will also learn something about his sighting arrangement. Open sights aren't as confusing as scopes. Practically any shooter can handle the simple adjustments incorporated into the rear sight. This is not the case with an optical sight. The scope is much more complex, and now that the vast majority of big game hunters are using scopes, it's imperative for the hunter to have a full understanding of how one works. The scope doesn't match a computer in complexity, but it is a complete sighting arrangement wrapped in one metal tube. Everything from seeing the target clearly to getting the bullet on the target stems from the hunter's knowledge of his scope. The more he knows about an optical sight, the fewer problems he'll have using it.

I want to make it clear that sighting in a rifle has many more benefits than just getting the bullet into the bullseye. We should approach the job as an opportunity to shoot until we have not only sighted the rifle in but also have, to some extent, sharpened our own shooting skills.

The second most asked question I encountered was, "How many shells does it take to sight in a rifle?" I've read several articles on how to sight a rifle in with two or three shots. In each case, the author seemed more concerned with saving ammunition than in helping the hunter understand his equipment. I'm not suggesting shooting just to hear the rifle crack, and I realize there are situations that warrant saving ammo. For instance, a hunter miles from base camp isn't going to do any group shooting if he drops his rifle. At most he'll fire one or two shots to check it out. On the other hand, to scrimp on ammo during a normal sight in is the wrong approach.

To me, a sight in session is a shooting session. I normally shoot 3-shot

Ray Johns watches as my son Darrel adjusts the Weaver scope on his M88 Winchester deer rifle. It's a 243, and Darrel often switches scopes on it to hunt chucks in the summer.

groups, waiting a few minutes between groups for the barrel to cool. I am in no hurry, nor am I out to prove how few cartridges it takes to zero in my favorite chuck or deer rifle. Even after I have the job completed, I almost always cut a group or two more just for practice. It sort of proves my efforts and gives me an extra ounce of confidence in my shooting skills with that particular rifle.

This may sound farfetched, but there should be a bond between the hunter and the rifle. They represent a team, and whatever is accomplished in the woods will be accomplished as a team. The more familiar the shooter becomes with his rifle on the range, the greater the chance for success in the woods. That's why it is imperative to shoot as much as possible before opening day. Don't run the risk of failure by not taking time to practice. If I'm carrying a rifle that has consistently produced less than 2½-inch 100-yard groups from the benchrest, I don't worry much about making a 150-yard ribcage shot in the woods. With any type of makeshift rest, be it a tree, stump or limb, I can use some of the techniques that produced the good groups on the 100-yard range. It's true that much of what is learned at the benchrest will carry over to woods shooting. I know it has for me.

Before heading for the range, be certain the rifle is ready and that you have the necessary equipment and tools to do the job. Above all else, make certain you have the correct ammo. This may be hard to believe, but I often had customers bring me ammo consisting of different brands, nose styles and bullet weights, and expect me to zero in their rifles. You can't

successfully use a mixture of ammo. Stick with the brand, bullet type and weight you will be using in the big game woods.

Some gun clubs are well equipped with benchrests, sandbags, and spotting scopes. About all the accessories the shooter has to furnish will be ear protectors, shooting glasses, ammo and his rifle. If you aren't fortunate enough to belong to this type of shooting club, use some type of sturdy table (a folding ironing board will do), with several sacks of sawdust or sand and a folding camp stool. Shoot only where there is a safe backstop, and try to find a spot that offers 100 yards or close to it.

I lost much of my hearing due to shooting, so I want to stress the importance of protecting your hearing at all times. I failed to do this. In other words, I did not wear ear plugs or muffs every time I fired a rifle on the range. Sometimes, it was a case of not bringing ear protectors along, but in many cases it was taking a "few quick shots" to test a rifle or shotgun. Usually, this was simply a matter of stepping out of my shop and firing into a steep bank a short distance away. Also, I would fire a shot or two from other shooters' benches without taking any precautions against the high noise level of big game and varmint rifles. Rarely did anyone in my area wear ear protectors in the 1950s and '60s. We just didn't realize what was happening.

There was not much emphasis on protecting the ear nerves prior to 1960. I don't recall ever wearing real hearing protectors in the military, though I do remember one range officer checking to make certain all shooters and coaches had cotton in their ears.

By the time I began wearing ear protectors regularly, apparently most of the nerve damage had been done. I locked the stable after losing the horse. What little hearing I have, I protect vigorously. I always were Silencio ear covers — I like them better than ear plugs for range work — when firing from the benchrest, and I use Bilson soft ear plugs under my ear covers when firing magnum handguns. That, in a sense, gives me double protection from the high noise level a magnum handgun generates. Whenever you fire a handgun or rifle, use some type of ear protection. Plain old cotton helps a little — but not much. Every handgun hunter and shooter should have ear plugs and ear covers when sighting in or practicing. It's not a bad idea to wear soft ear plugs while hunting. Don't make the same mistake I did. If you do, you'll have to live with it for the rest of your life.

If it's important to protect your hearing, it's even more imperative to protect your eyes. I have experienced two rifles letting go under my face. Shooting glasses saved my eyes with the first blow-up, and my regular eyeglasses stopped the hot gases and burnt powder residue from scorching my eyes when the second rifle came apart. Black powder shooters are

especially susceptible to eye damage from miniature bursts of burning powder and gases that spurt from the nipple or touchhole. Always wear both ear and eye protectors.

In a previous chapter, I discussed the benchrest and various shooting techniques. While all that is important, it's also important what type of target is used. I've fired at almost every conceivable style, from the crude to the deluxe. My favorite is a 3-inch black square with a 1-inch white square in the middle. On both sides and on the bottom are 1/2 x 2-inch black bars, to superimpose the reticle on and aid in keeping the rifle from canting. Severe canting causes the rifle to shoot left or right. The small white square in the middle of the bullseye makes an easy-to-see center reference point.

For big game rifles with low power scopes, this is a relatively small target. With older 2 1/2x scopes which had reticles that looked as thick as lead pencils, it was difficult to find the bullseye under the reticle intersection. The customer wanted the rifle hitting the black square. If the bullseye had been 6 inches in diameter, I'd have had fewer problems.

When I was a youngster, my brother Dan had a new rear sight installed on his deer rifle. When we picked it up, Dan asked if the rifle had been sighted in. The old gunsmith not only assured Dan that it was but, just to prove it, he stuffed in a cartridge, opened a window and sent dust and debris flying from a rock some 60 yards away. I was really impressed. On the way home, I kept talking about what a good job the old 'smith had done, and how well he could shoot. Finally, Dan pointed out that the rock was the size of a washtub, and that I probably could hit it with my slingshot. He didn't know where the old man was aiming, and he didn't know where the bullet hit the rock; it was a wasted shot that proved nothing. It took a few seconds for Dan's comments to sink in, but I learned a valuable lesson on shooting at a very tender age.

The small 3-inch bullseye with its white center often caused me headaches. Most customers wanted their rifles to hit the one-inch white squares. Even when a bullet hit the edge of the black, which was only 1 1/2 inches from center, they would point out that I was shooting "way to the left or right." When a bullet landed in the white outside the bullseye, it was a big miss so far as the customer was concerned.

Today, many different types of targets are available, especially designed for zeroing in a rifle. I suggest using these targets, but don't allow the lack of a store-bought target keep you from zeroing in your rifle. It's relatively easy to make a sight-in target. With a wide black ink pen, draw a 12-inch plus (+) sign roughly 3/4-inches wide. Fill in a 4-inch black square at the intersection of the plus sign bars. This size aiming point is adequate for even low power scopes at 100 yards, and the crosswire in the scope can be superimposed on

the bars of the plus sign. This will help eliminate canting, and also help keep the intersection of the reticle in the center of the black square. Almost any target will work, but one that has some method for reducing canting will benefit new shooters.

A friend who does a lot of shooting came up with a good idea. To eliminate the task of making a new target each time, he xeroxes batches of 50. The target is more important than most shooters think, and that is why I feel it's important to use the best possible, whether it's purchased or homemade.

A lot of ammunition can be saved with bolt action rifles by bore sighting them first. By removing the bolt from the action, you can see through the bore. First and foremost, bore sighting is only a means to get the bullet on the paper. Going into a lot of detail to make it precise is a waste of time. Once the bullet lands on the target, you can adjust the scope, or some mounts, to put the bullet into the black.

Placing the rifle firmly on two sandbags and centering a bullseye 50 yards distant in the center of the bore usually gets me on a standard size target paper. To do this requires some delicate maneuvering. When the rifle is solid on the sandbags and the target appears to be in the center of the bore, I peek through the scope without moving the rifle, to see where the crosswire intersection is in relation to the bullseye. Since it's almost impossible to adjust the scope without moving the rifle, I've found that by estimating how far, both vertically and horizontally, the intersection is from the center of the bullseye, the rifle can be removed from the bags to make the required scope adjustments. Double check before shooting.

There is another way to do this that many shooters feel is better. It requires a scope with enough magnification to see a bullet hole. Shoot at the dead center of the bullseye, and then locate the bullet hole through the scope. With the rifle firmly supported on the sandbags, again hold the reticle on dead center and turn the metering wheels until the reticle is on the bullet hole. I must warn you that this requires holding the rifle so that it can't move while making the necessary adjustments. This is easier said than done. And even if properly done, it does not guarantee a good zero because there's no way of knowing in advance if that single shot would have been the center shot in a group; it could just as easily have been the highest or lowest, which means you have made a precise adjustment to the wrong place. That's why, unless you have an extremely accurate outfit, it's better to zero in by firing a 3- or 5-shot group and using the center of it as the basic zero.

Bore sighting is possible with bolt action rifles, and it's possible to use a tiny mirror, such as a dentist mirror, to look through the bore of pumps and levers. This is a nerve-wracking experience, and it's far easier to begin by

firing at a target only a short distance away. Adjusting the scope to hit the bullseye here will definitely put your first shot on the paper at 100 yards. From that point, it's only a matter of refining the adjustments to place the shots where you want them on the target.

Many shooters sight in their rifles at short range, and assume it will be okay out farther, but I have never been a strong advocate for the 25-yard sight in. I know it can be done, and I know shooters who use this method successfully. Perhaps I am spoiled because I have always had ranges up to 300 yards equipped with solid shooting tables. I don't mean to criticize the short-yardage method, but I like to see what my rifle is doing at ranges I will face when in the fields or woods. It is advisable to start the sight in at 25 to 30 yards. At these short ranges, it's unlikely you will miss the target completely. Make the necessary sight adjustments to put the bullet exactly on point of aim here and then move the target to a full hundred yards.

A device used extensively to aid in sighting in a rifle is the collimator. When I was a struggling gunsmith trying to mount scopes without a drilling jig, strictly by trial and error, I seldom drilled and tapped a rifle without having some type of centering problem. When I read about the collimator and how it would perfectly align the scope's reticle with the bore, I lost no time in sending my check. I felt this bore-sighting device would be a panacea for all my scope mounting and sight in problems. Well, my thinking was off base, and so is anyone's who feels that a collimator guarantees a perfect sight in. It doesn't. Nevertheless, it is unquestionably one of the handiest devices ever invented for a gunsmith because it can get you somewhere on the paper without firing a shot. Thus it saves time and ammo when zeroing in rifles. When I operated a scope sight-in range, my first step was to check the scope with a collimator.

Howard Mortimer looks at grid in collimator to make his initial scope adjustments. This usually gets first shot well on paper, and from that point final zeroing is easy.

A collimator is a small optical device that fits into the muzzle by utilizing barrel spuds of various calibers. The spud is pushed into the bore until its tapered end rests firmly against the muzzle. A protruding curved spring incorporated near the end of the stud exerts pressure on the inside of the bore to keep the collimator from moving. Inside the collimator, depending on its make, is a crosshair, X-reticle, or calibrated grid which forms a reference point that's visible when you look into the scope and indicates the place your bullet will hit on the paper.

Many shooters think that adjusting the scope's reticle until it is superimposed on the collimator's reticle indicates perfect alignment with the bore. That's fine for a gunsmith checking out a scope's basic alignment with the bore, and, unless there are major barrel or stock problems, this type of setting will put the bullet somewhere on the target. But it rarely gives a precise zero.

I use a slightly different approach. Although I always superimpose the vertical wire of the scope's reticle on the center vertical line in the collimator, I place the scope's horizontal wire slightly below the horizontal wire in the collimator. In essence, I allow for the bullet's drop on its way to the target. Since each grid in my collimator equals 4 inches at 100 yards, I use about one-half grid down for high velocity cartridges, and a full grid for slower loads. The farther down the location, the higher the rifle will shoot. It's the same as adding elevation in the scope.

I have used collimators for over 25 years, but in only a few cases was the rifle in zero on the first shot. Most of the time, the bullet was a considerable distance from the 3-inch bullseye. In all fairness, a shooter using nothing but a collimator for sighting in his rifle might have hit a deer or bear at woods ranges, but why carry a rifle that is five inches to the right and four inches high, say, when a few shots and scope adjustments would put the bullets dead center?

I have vented my feelings many times over the "mechanical" sight in theory. Despite all the collimator has to offer, it just isn't a true sight in device. Unfortunately, many sports shops and some gunsmiths advertise it as such. Here is an actual episode that I witnessed.

The sales clerk mounted a scope on a customer's new rifle. He did no checking of eye relief or eye focus. When the installation was finished, the clerk asked if the customer wanted the rifle zeroed in for an additional cost of three dollars. The man said he did, but asked how it could be done at night in the middle of a city. He was told that a special sighting device was used, and there was no need to fire the rifle.

Another clerk was called. Apparently he was the sight in specialist. After

attaching the collimator, he looked through the scope and made several windage and elevation adjustments. He then put the caps back on the scope and handed the new outfit to the customer, telling him the rifle was dead on at 100 yards. The man left, but was back in less than a minute. He wondered if it was possible to zero the rifle in for 150 yards, as he hunted in fairly open terrain. The clerk nodded proudly and again inserted the collimator in the muzzle. After making a minor elevation adjustment, he gave the customer his rifle, assuring him he was right on the button at 150 yards. By this time my stomach was in knots and I was tempted to get involved, but my better judgement told me to just leave.

Years of experience convinced me there is no way a rifle can be reliably sighted in just by using a collimator. A gunsmith friend who was determined to prove me wrong filled a notebook with schematics and drawings. Each time he zeroed in a rifle, he checked the scope's final reticle setting with the collimator. He then make a drawing showing the collimator's reticle in one color and the scope reticle's position on the grid in another color. All ballistic data were also recorded for future reference. This was a horrendous amount of work and, after three months of painstaking record keeping, he found that it didn't work and unceremoniously tossed his notebook and targets into his shop's potbellied stove.

A collimator is a great help in making the initial reticle setting. It saves ammo and cuts down on frustration. But don't put your faith in any mechanical reading. Find out from the benchrest where your rifle is placing its shots. The holes in the target will speak for themselves.

It's wise to double check all scope and gun screws before the shooting starts. Make certain the scope is focused for your eyes. Manufacturers prefocus news scopes so the reticle is in focus for shooters with 20/20 vision or vision corrected to 20/20. With a scope, the ocular lens (eyepiece) can be adjusted to correct most cases of farsightedness and nearsightedness. For many years while I was developing hyperopia (farsightedness), I found it difficult to hunt with glasses on, yet I used prescription glasses for range work. This meant I had to change the scope's focus when I went hunting. The difference was minimal, but enough to slightly blur the reticle if not corrected. Naturally, the shooter who is myopic (nearsighted) can also adjust the ocular lens to bring the reticle into perfect focus. It's a simple operation to focus a scope for your shooting eye.

To check the ocular lens focus, look through the scope for second or two against a plain or neutral background such as a dull sky or a softly lighted wall. If the eyepiece is properly focused, the reticle will appear sharp and black. If there is even a little fuzziness or distortion, the scope is not perfectly

focused for your eye. When checking the reticle for a longer time, the eye will adjust to make the reticle appear in focus when it is not. This will cause eyestrain eventually.

To focus the eyepiece, loosen its lock ring and then turn the eyepiece counterclockwise (back it off) until the reticle is completely out of focus. Do not remove the eyepiece. It isn't necessary, and to do so could allow moist air to get into the scope. When a quick glance shows the reticle is hazy and distorted, start screwing the eyepiece clockwise. After four or five turns, check the reticle again. Continue until the reticle is sharp and black. Since there are normally 64 threads per inch on the eyepiece, precise adjustment is possible. I screw the eyepiece several turns farther after the reticle appears sharp, just to make sure I have the best focus possible. When the reticle starts to blur again, I turn the eyepiece back until I have a perfect focus. When I'm satisfied, I tighten the lock ring against the eyepiece. If the reticle is focused this way, there is no need to change it unless the shooter's visual acuity changes.

It probably seems by now that after checking the scope's focus, its mounting setup and the rifle's stock crews, it's time to feed a live round into the chamber and shoot. Not quite. There is still another important step to go through before the first bullet is sent downrange: dry firing. Dry firing is a term many shooters haven't heard since they left the military. You may wonder what in the world dry firing a rifle has to do with sighting it in. That's a good question, and it deserves a good answer. We tend to think of dry firing only in relation to getting the proper sight picture and releasing the trigger. That is the main function of practicing without live ammo, but dry firing has another important benefit. It can reveal mistakes the shooter makes when he pulls, or jerks, the trigger. We lump all the mistakes that can derive from this under one heading — flinching.

My thesaurus also refers to flinching as cringing, wincing or jerking. In a shooter's terminology, it raises the subject of recoil. Maybe I can make it clearer by stating it's the fear of recoil that causes us to flinch. Recoil plagues all shooters. We can overcome a host of shooting problems but, if we flinch, we miss.

Flinching carries a stigma; it makes us a bit ashamed, as if it's something unmanly, so many shooters won't admit they flinch. But everyone does occasionally. When we aim a big game rifle, recoil often dominates our thinking. It destroys our ability to concentrate on the sight picture. Even when we try to ignore the upcoming impact of a magnum cartridge, it's almost impossible to relax and let off a well-aimed shot. From what I have seen, this causes a tendency to hurry the shot by literally yanking the trigger.

Taking too much time can also cause a shooter to flinch. For the most part, excessive aiming exhausts the shooter. When he aims much longer than five to eight seconds, tension begins to build in his body. Muscles stiffen and the heart rate increases. Confined air in his lungs is fighting to get out. In a matter of seconds, the nervous system is under stress, and his ability to concentrate is lost.

Learn to get a shot off within a few seconds. The instant the heart starts to pound and the lungs begin to cry for fresh air, stop, take a few breaths, and start over. But first, get things in order so that it will take only a few seconds to fire the shot. This is what dry firing will bring to light.

Flinching is so much a part of shooting that many of us even flinch the first few times we dry fire a rifle. Dry firing will help a shooter free the body of all tension and frozen muscles. The mind, not fear, must control the body. Dry firing won't completely eliminate all the preconceived fears, but it will certainly teach a shooter how to hold a sight picture while making an even pull against the trigger.

Bench shooting techniques are covered in another chapter, but it bears mentioning that it's important how we position ourselves at the shooting bench. This applies to dry firing just the same as it does when firing with live ammo. You can't just plop down at the bench and start to shoot. A few basic rules must be considered. When dry firing, it's imperative to position the body and rifle in the same manner as when live firing. Dry firing is a simulation of the live firing and the approach should be identical. Everything you do in dry firing should prepare you to switch to live ammo. If live firing procedures don't exactly duplicate the dry firing measures, nothing was gained during the dry firing session. You can't change shooting procedures and expect to get good results.

It's not only important how you sit at the bench, but it's also important how the rifle is placed on the sandbags. Perhaps it's not absolutely necessary to rest the forearm of a glass-bedded rifle on the front sandbag, but I'm convinced it is the best way to shoot big game rifles. The rear bag supports the stock and aids in keeping the rifle level. A lot of shooters use only a front bag, and support the buttstock with both hands and elbows. With this setup, the left hand grips far back on the toe of the stock. I prefer two sandbags as this method takes more of the human element out of the hold.

Although in the benchrest chapter I suggest sitting at an angle with the ribcage slightly touching the bench, shooters who are conscious of recoil should face more forward and keep the body upright, instead of sagging low on the bench. With the shoulder in a high position, recoil will push it backward, bending the back at the midsection of the body. When the body is

hunched over the bench in a low position, recoil drives the buttstock directly into the upper part of the shoulder, which is being supported by the back, and that can be painful.

There is an ongoing argument whether the hardness of the front sandbag has a direct relation on the impact of the bullet. I don't pretend to have the final answer here, but from 30-plus years of shooting from a benchrest, I lean toward the theory that the harder the front rest, the more the rifle jumps. This might not apply to a super-heavy benchrest rig, or a small-cartridge, heavy-barrel varmint outfit, but it sure does with conventional big game rifles. I call it bouncing, others term it as jumping or shooting away from a hard rest. I can state unequivocally that a super hard front rest has a definite impact on bullet placement.

For many years I have used a standard set of Hoppe's leather bags filled with plain sand on the bench. Shooting, plus adjusting the rifle on the front bag, compacts the sand, and this is doubly true with hard kickers since they are held tighter on the bags. Before each shooting session, I loosen the sand in the front bag by pounding or twisting it for a few seconds. If you think that the compactness of a front rest has nothing to do with the impact of a bullet, try zeroing in a rifle by resting it on a block of wood covered with a

T. R. Them uses high-eared bag to support rifle during sight-in. Such an arrangement helps preventing canting, but support channel must be properly aligned or it exerts force to the side.

cloth. You'll see instantly what it meant by jumping or shooting away from the rest.

Good shooting hinges on trigger control, and the idiosyncrasies of a trigger can not only be learned but also mastered by dry firing. Eliminating flinching may be the number one benefit from dry firing, but close on its heels is trigger control; in fact, many top shooters feel that mastering the trigger is what dry firing is all about.

The trigger is not just a piece of metal protruding out of the rifle's action; it's the shooter's primary means of communication with the shot he is about to fire. The benchrest can be immovable, the sandbags of the right consistency, and the ammo loaded with near-perfect precision, but it's all to no avail if everything is not culminated in a perfect trigger pull. I'm convinced the trigger is the least thought about part of a firearm. Nearly everyone believes the stock must be altered to fit the shooter, the action glass bedded, and a scope mounted properly, but who cares about the trigger? Every shooter knows where it is and that to fire the rifle it has to be pulled. There's not too much wrong with that, except how it is pulled and that the pressure needed to do that can spell the difference between success and failure. The trigger is the final link between the hunter and his shot. I don't want to be dramatic, but the pulse of a fine rifle is its trigger.

I have always thought of certain triggers as being compatible with certain shooters. Helen, for instance, likes double set triggers on varmint rifles. She appreciates the extremely light touch required to set off that type of mechanism. It suits her philosophy of the art of precision varmint shooting. She is unable to concentrate on the sight picture if she has to struggle with a heavy trigger. For myself, I want to "read" or "feel" a trigger. I like to make solid contact against the face of the trigger and then apply several pounds of pressure to release the shot. I need to make contact with the trigger, but it's obvious she doesn't.

A lanky six-foot friend has hands so callused from hard work that for him even a 3-pound trigger is too light for varmint shooting. His hands are strong and tough, and he does top shooting with triggers that touch the 5-pound mark. However, I don't want to give the impression that a person's size or strength is the only factor that determines proper trigger setup. Weight of pull is not the only aspect to be considered. Other guidelines should be taken into consideration when you are selecting the type of trigger best for you.

Generally, a trigger setup is a combination of three things: free play or slack, weight of pull, and override. Free play is the backward movement of the trigger before it releases. Pull is the pounds of pressure needed to release the firing pin, and override is the continuing movement of the trigger after

the firing pin has been released. A trigger setup that allows the shooter to fire the shot precisely requires that the free play be eliminated so far as possible, the pull be compatible with the shooter, and the override be reduced to a minimum. When this is accomplished, the trigger will be crisp. I have often referred to this type of trigger as being hard. It's not hard in the sense of being heavy in pull weight, but it feels solid when the index finger engages it. There will be almost no perceptible movement as the trigger breaks, and after the firing pin is released the trigger will not travel farther backwards to pull the shooter off his mark. This type of trigger may require some getting used to, but it won't take long to realize its benefits.

With free play and override out of the picture, we come to grips with the pull. It's not my intention to set standards. I have already explained how several shooters feel. The weight of pull is personal, although I feel that any pull above 5-pounds is excessive in any trigger. A 5-pound pull may sound on the high side, but the big game hunter, who often shoots with gloves on, would not want a light trigger pull on his rifle as it would probably go off before he felt it. A crisp 5-pound pull would not adversely affect his shooting, and he would be using a trigger that would withstand some of the problems of cold weather big game hunting.

When I was gunsmithing, adjusting triggers was one of my most challenging endeavors. A trigger with two or three adjusting screws is fairly easy to transform into a good trigger. On the other side of the coin, adjusting some military-type triggers, and those I will call just "plain triggers," will test the skill and patience of the most competent gunsmith. A few are impossible to adjust. Others can be helped to a certain degree. I would hone and then strop trigger mechanism parts on leather, but I was always leery of doing much with a file. When adjusting triggers such as those on the Savage 99 and Winchester 88 lever action outfits, my main goal was only to take the roughness out. While that did little to reduce the weight of pull, the fact that it was smoother made it easier to operate, and the weight of pull was more consistent. One trick with triggers that had too much override was to drill and tap the rear of the trigger guard and install a stop pin. This tiny threaded pin incorporated one or two lock nuts and could be adjusted to stop the rearward movement of the trigger immediately after the firing pin had been released.

A late gunsmith friend was very good with Mauser and other types of military triggers. He made several major modifications, but I always had reservations about making drastic changes, especially in removing metal or altering certain parts. I was always afraid the trigger would become unsafe as it began to wear.

Many shooters are so sloppy that the pull weight reading will be different literally every time it's checked. I didn't set a goal of some specific pounds of pull; rather I strived to take the sloppiness out by drilling worn holes to a larger size and then making pins to fit. Taking out most of the sloppiness made a trigger that was consistent in pull weight. Big game rifles work very well with pulls running 3½ to 5 pounds, and the higher weights practically guarantee safe triggers in the tough terrain encountered by most big game hunters.

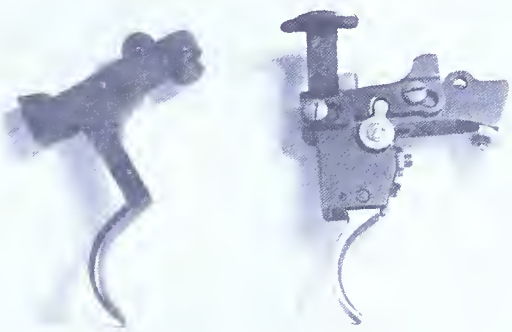
Varmint hunters tend to opt for pulls below 4 pounds as there is no element of hurry in this type of hunting. With a super-light trigger, I don't load the rifle until the chuck is spotted and I have placed the rifle in shooting position. Also, I never lend a rifle to anyone without first explaining the trigger pull. Most of the time, I have the person who will be using the rifle dry fire it several times to get the feel of the trigger.

It's now time to place the empty rifle on sandbags and learn how to dry fire. In case you worry about damaging the internal parts while dry firing, there is no danger in snapping a centerfire rifle on an empty chamber. The nose of the firing pin doesn't strike anything. Some shooters put a fired case in the chamber, but I've never liked that idea. I want to see an empty chamber. The situation is different with a rimfire rifle. Its firing pin will strike the rear face of the barrel, damaging the end of the firing pin and pounding an indentation into the barrel. When the firing pin strikes a loaded cartridge, its rim can be pushed into the indentation, causing a misfire. When adjusting rimfire triggers, I used a fixed case as a buffer between the firing pin and the barrel.

This is a good place to mention that dry firing is not a one-time affair. It should be done often and with every rifle. Some shooters feel guilty about sitting at a benchrest and snapping the firing pin on an empty chamber, and say they are not sure it's worth the time. I can assure you that dry firing is still the best self-instruction method for beginners and veteran shooters alike. But it must be done conscientiously. Then it reaches self-control and how to be repetitious — how to fire every shot with the same sight picture, breath control and trigger pull.

When you sit down at the bench, get comfortable and assume the same position you will use with live ammo. Adjust the rifle so the sandbags support it in such a manner that all you have to do is move your shoulder against the butt pad and look through the scope. There will always be some secondary adjustments, but try to get it as close to a conventional shooting position as possible.

On a big game rifle, the shooting hand should grip the stock firmly, while



Military Mauser trigger, left, is simple, sturdy, dependable, but does not supply the light crisp pull of the fully adjustable trigger at right. Latter also has an integral safety.

the other hand pulls down the forearm. How tightly the gun is held and how much pressure is applied to the forearm depends on the recoil of the cartridge and weight of the rifle. The three fingers on the shooting hand should pull the stock back into the shoulder pocket, but not push the stock into the cheek. On heavy recoiling rifles, the cheek should bear firmly on the comb. The more a rifle recoils the tighter I hold it.

Pulling down on the forearm helps stabilize the rifle and keeps it from bouncing off the sandbag. I do not know of any formula for determining how much pressure to apply, but I use the Lewis "lobe-of-the-ear-method" for demonstration purposes. This utterly scientific method requires grabbing an ear lobe between the thumb and finger of the forearm hand, and pulling down until it hurts. Depending on the toughness of your ear, the reading on a pull scale will probably come out somewhere between four and six pounds. The higher the recoil, the more downward pressure used.

With the rifle firmly on the bags and the reticle on the bullseye, the next major step is releasing the trigger. Although I have been guilty numerous times in talking about trigger squeeze, there really isn't any such method. You squeeze a lemon, but not a trigger. A trigger is not squeezed; it's pulled, pressed or pushed. The word "squeeze," when applied to releasing a trigger, is a misnomer, but it has become so imbedded in the shooting vernacular that it's constantly used, even though it doesn't correctly describe how to release a trigger.

A trigger is a solid piece of metal. It has no give in it. On a firearm, the firing pin is released after pressure is applied against a protruding piece of metal known as a trigger. Applying even and steady pressure eliminates flinching. Some shooters, especially beginners, have a tendency to hurry the trigger pull. That is the basic reason for a flinch. An even, steady pull requires time. Undoubtedly, telling the shooter to "squeeze," as was done in

the military, helps overcome a desire to yank the trigger. The goal is to slow down the trigger's release. A better term would be "even pull."

Why make an issue of it now? As it says in Ecclesiates, Chapter 3, Verse 7, "there is a time to rend, and a time to sew; a time to keep silence, and a time to speak." I think it's time to set the record straight; it's time to lay the term "trigger squeeze" to rest.

As explained earlier, dry firing can reveal the aiming and trigger release mistakes that cause misses. Trigger setups, custom or not, are not identical. Each trigger has to be dealt with separately. No two release exactly the same. I call these tiny quirks "trigger idiosyncrasies." No matter what they are called, they have to be overcome by the shooter. Dry firing will point out these eccentricities quicker than live firing, as there is no recoil effort to hide what is happening. A flinch is rarely visible when firing, but it's plain as the nose on the face when the chamber is empty. It's imperative for the shooter to know when the shot will go. Few shooters can hold a perfectly steady sight picture while releasing the trigger.

A top indoor rimfire competitor told me he swept his reticle slowly from right to left across the X-ring. When the reticle's intersection barely touched the X-ring, he released the trigger. He timed it with clock-like precision. He also knew his trigger setup. It's unlikely the average hunter will attain that degree of perfection, but a few minutes spent dry firing before each shooting session will give the hunter valuable experience with his trigger.

The final phase of the dry firing process is the actual trigger pull. To start with, there is no exact procedure for placing the shooting finger on or against the trigger. I have used one method for over 30 years with great success, but every shooter eventually ends up with his or her individual style. With conventional big game cartridges and the super mag jobs, I use what I term a "grip" method. This means I place the second joint of the shooting finger against the face of the trigger and tighten the entire hand, while pulling the trigger. This definitely helps to eliminate flinching with heavy-recoil cartridges. Weaknesses with this method, I have been told, are that the shooting finger is not coming straight back and the shooting hand is not controlling the stock.

One very fine shot who vehemently criticized this method didn't have a lot to say when he studied a 5-shot ragged-hole group I printed with a Remington 7mm Magnum. He reluctantly admitted it might work now and then, but insisted it was the wrong way to release a trigger. That type of thinking puts me in mind of the critic who said the automobile would never run. When it did, he said, "It won't stop."

If I have been using the wrong trigger pull, it's what evolved for me over

years of shooting when I often fired up to 30 rifles a day. When I zeroed in five magnums and 25 conventional rifles in a six hour period, firing up to 10 shots in each, I had to be doing something right.

Many top shots release the trigger with the first pad of the index finger. The advantage is a straight back pull. I have no objections to this method, and I do use a similar system with lightweight triggers.

Helen and I have enjoyed close to 47 years of shooting together, but she doesn't buy my second knuckle theory in any way, shape or form. In the early days of my sight-in range, she did her share of shooting from the benchrest, and got top results to boot. In fact, some customers attached a note requesting that Helen do the shooting. Darn humiliating, especially when I advocated the "grip" system.

Many aspects of shooting, including the trigger release, are personal matters. Not every .300 hitter in the major leagues uses the same batting stance, but so long as the hits go out and the runs come in, no batting coach is going to tell him he's all wrong. My advice is to develop a system that satisfies your psychological side and produces good scores. My method may be considered unorthodox by others, but it has worked for me. Some benchrest shooters place the thumb against the rear of the trigger guard and the first pad of the index finger against the trigger, and "pinch" off the shot. Even with a 2-ounce benchrest trigger, I can't successfully do that. You will have to work out what is best for you. It might be one of the methods covered here, or it could be a combination of several systems. Whatever comes naturally is the way to go.

Once the trigger is pulled and the shot is on its way, the end is not yet. There is a follow through, just the same as in golf or baseball. How can there be a follow through once the shot is fired, and just what is its purpose?

A follow through is simply staying with the sight picture and trigger pull after the firing pin has fallen. It comes right down to having total disregard for the backward thrust of the rifle. If the muscles begin to tighten and the heartbeat increases as the finger presses the trigger, a flinch is almost inevitable. That proves the problem begins before the shot is fired. At least, that is when the flinch begins. Concentrating on the sight picture while increasing the pressure against the trigger and then properly following through eliminates flinch. This type of trigger letoff can be learned best with a heavy barrel, small cartridge varmint rifle that has little recoil but a lot of muzzle blast. When you come to grips with flinching, muzzle blast is a major contributor.

Considering all that I have written in regard to dry firing, it may appear to be a complex and frustrating process. Nothing could be farther from the

truth. Dry firing is just firing without live ammo. It's the blueprint that will be used when the firing pin is hitting live primers instead of air. Live firing is basically a duplication of dry firing.

How is it accomplished? The shooter starts by putting on ear protectors and shooting glasses (unless he wears eye glasses, in which case they should be shatterproof), and checking the rifle to be sure there are no live rounds in the magazine or chamber. The next move is to get comfortable, with both feet flat on the ground. Place the rifle on the sandbags at the proper height. Take a few seconds to get the reticle close to the bullseye. Oxygenate the lungs by taking a deep breath. Exhale most of it, and , while holding the remainder of air in the lungs, move the reticle onto the bullseye, steady it there, and complete a smooth, even trigger pull. If you are really concentrating on the aiming picture, you will undoubtedly see a tiny jump when the firing pin falls, indicating a subconscious flinch. It may take a dozen or so attempts to eradicate the flinch. The paramount goal is to see exactly where the reticle is on the target when the firing pin stops its journey. That's why it's imperative for the shooter to know exactly when the shot is fired.

Making drastic changes in the body position should be avoided. It might be too much to flatly state that standing up or shifting the body between shots will ruin a group, but it sure won't enhance one. Once I'm sogged down on the bench seat, I do not want any distractions. My sole desire then is to get 3 or 5 shots downrange, with each being sent on its mission exactly as its predecessor was. Repetition is the key word in group shooting.

Many of the shooting woes that plague a hunter can be diagnosed and cured during dry firing sessions. Far too many shooters, hunters especially, take a too casual view of dry firing, if they ever think of it at all. If it's taken seriously, and if the shooter is willing to spend some time getting acquainted with the trigger pull, releasing the trigger precisely when the reticle is in dead center, and learning self-control, his live shooting sessions will be more enjoyable and a whole lot more productive. Whoever came up with the idea of dry firing made a significant contribution to the shooting clan.

Live Ammo Sight In

THE MOMENT OF truth has arrived; it's time to feed a live round into the chamber. Make certain all safety considerations have been taken care of — eye and ear protection, a safe backstop, and no one in front of the muzzle. The ammo should be checked to be certain it is the correct caliber, and that it's of the same brand and bullet weight.

Maybe a moment of discussion on the best type of target might be helpful. I prefer black and white targets. I have tried many styles but I am not a fancier of colored targets. I have used fluorescent, red, green and bright blue bullseyes, but they always appear slightly out of focus to me, probably due to their brightness. It's hard to beat good old-fashioned black and white targets, for either daytime use or shooting under lights.

My 100-yard range is electrically illuminated for night shooting. I use targets printed on a roll and can bring a fresh target into position by flipping a switch alongside the benchrest in my testing shop. In approximately 15 seconds, a new target with multiple aiming points is centered in the target house window. This setup is convenient, and permits me to shoot in all types of weather and light conditions.

Our oldest son Darrel, who is a professional engineer, draws what I want, and then the 18 x 22-inch target is photographed and printed on white paper. For the most part, I have stuck with a 3-inch black square that incorporates a one-inch white square in its center. With low power scopes the white square might not be visible, but I simply use the larger black square. I'm a firm believer in small aiming points for precise testing. To prevent canting of the rifle, I had short horizontal bars, level with the white square, printed on both sides of the bullseye, and a vertical one centered at the bottom. These are very useful, but keep in mind the target must be level.

I suggest that beginners shoot at shorter distances and use larger targets. A

good starting distance is 50 yards. Use a black 5-inch bullseye on a two-foot square of white paper. Even with open sights, this type of target is easy to see. Someone new to the shooting game is not out to set records. The paramount goal is to learn a few things about the rifle, and to finally get the bullets to impact in the bullseye.

Allow me to inject at this point something I learned early in my shooting career — avoid like the plague shooting in front of a crowd. Most persons who attempt to sight in a rifle in front of a large number of other shooters immediately become conscious of their presence. You're not shooting for yourself; you are shooting for them. You will become flustered and your results will show it. Sighting in your rifle is a personal matter. You should be able to concentrate on what you are doing. The last thing you need is a crowd. I don't like confusion around the benchrest. When there is noise, milling shooters and advice coming from a dozen sources, the ball game is lost for me. I'm not suggesting you turn a deaf ear on good advice, especially from a qualified rifleman, but you'll feel much more at ease shooting alone or with one or two people you know and trust.

Don't put a live round into the rifle before looking through the bore. This may seem superfluous advice, but bores can become clogged in some very strange ways. Here's what once happened to Helen and me.

One evening we shot a few chucks with a 25 Niedner (the 25 Niedner was the wildcat forerunner of the Remington 25-06). Later, I swabbed out the bore and placed the rifle on a rack in my shop. The next evening we decided to zero it in for 300 yards to take care of some chucks in a neighbor's field. Helen filled the magazine and shoved a round into the chamber. After a few seconds of aiming, she pressed the trigger. The only sound was a distinct click as the firing pin fell. We were baffled.

When she ejected the round, I checked the primer to see why it misfired. The indentation in the primer was extremely shallow. That was mystifying, as this particular Mauser bolt had a very strong firing pin spring. I was intent on studying the primer when Helen said, "Can you believe that?" I nearly fell over when I discovered that the muzzle end of the bore was completely packed with mud. It took several minutes to push the obstruction out of the muzzle. I'm not a biologist, but from all appearances some type of insect had built a nest in the muzzle. It was scary. Only an incredible coincidence gave a misfire on a shot which could have been disastrous if the rifle had fired. The incident taught me a valuable lesson and since that day I have checked the bore of every rifle before feeding a live round into the chamber.

Even though you have learned to hold a perfect sight picture that culminates in an even trigger release, the psychological side of a shooter

takes over when a live round is chambered. Dry firing experience helps — it builds good habits — but the fear of recoil has an effect when recoil becomes a reality. It happens to me and it will happen to you. The mind never fully accepts the idea that the body should be bruised, and some part always seems to be concerned with fears of recoil which, for the most part, are grossly exaggerated.

Recoil is an integral part of shooting, and fears and apprehensions don't disappear like water running off a duck's back. But, like falling drops of water that wear away a stone, practice sessions will eventually wear away the fears that are embedded deep in the shooter's mind. It's best taken a step at a time, working from small cartridges to more powerful ones.

It's a rare shooter who can feed a round into a big game rifle and not think about recoil. I'm stressing this point because recoil is the Achilles' heel of shooting. It's the demon that keeps many of us from concentrating on the sight picture and easing off a clean shot. I strongly advocate using a good shoulder-type recoil pad. If you're shooting a magnum cartridge, use a thick piece of carpet between the shoulder and the recoil pad for extra protection. Don't be a hero; protect your shoulder muscles from abuse.

With a live round in the chamber, it seems to be time to sog into a comfortable position, hold a steady sight picture, fire your first shot for group. That's how it appears, and that can be done, but why not fire a test shot to get acclimated to the muzzle blast and recoil. This shot is not for record purposes; it's more to get the shooter psychologically and mentally adjusted. I often let one fly at a sighter target just to get the feel of the cartridge I'm using. When you do this, there will be no surprises from noise and recoil when you settle into a comfortable shooting position for your first sight-in shot.

I'll assume your rig has been bore sighted or checked with a collimator. If either of these has been done, the first shot should strike someone on the two-foot-square target. If neither has been done, begin with a big target at short range — 25 yards is fine — and adjust the scope until the bullet is in the black. Then go to the 100-yard target. Get comfortable at the bench. After taking a deep breath and exhaling part of it, the reticle is held motionless on the bullseye and the shooting finger presses evenly and firmly against the face of the trigger. It's almost a certainty the rifle will fire when the shooter is not expecting it, but don't worry. That problem will be worked out in later shooting sessions. See where the bullet hit. If you don't have a spotting scope, it's wise to unload the rifle and walk to the target, especially if the scope being used is 4x or lower. I know from experience it's possible to mistake a splotch, black mark or even a fly for the bullet hole. Circle the

bullet hole with a heavy pen. At this point, you will certainly ask, "How many shots should I fire before making scope adjustments?" Let me take you back to my early days.

Shortly after the end of World War II, thousands of returning veterans, myself included, were attempting to get accustomed to civilian life after years in the military. I had spent 42 months in the service, 15 of them in the ETO — the European Theater of Operations. Trying to find a job and a place to live consumed most of my time and military savings. Eventually, I got a job and bought a home with a GI loan. The next important objective was getting back to shooting.

Handloading was sweeping through the hunting ranks, and around 1950 I latched onto a Lyman Tru-Line Jr. reloading press to satisfy the insatiable appetites of several varmint outfits. I eventually learned that reloading was more than just cranking out inexpensive handloads. After spending several years trying to develop top reloads for hunting purposes, I realized a handloader has to test his fodder. This led to my first benchrest and 100-yard range. I didn't have any blueprints to guide me. I built the bench and designed a fore-end rest from looking at photographs in several magazines. All I can say now is that the bench was strong and the front rest held a sandbag. As I might have mentioned, a friend remarked that my efforts looked like a carpenter's nightmare.

When I began zeroing in my varmint rigs, I was under the impression that a 3-shot group had to be fired before making a scope adjustment. I would boresight the rifle and then fire a round. If I was fortunate and hit the target paper, which was quite large, I fired two more shots to make sure the rifle was impacting about where the first shot hit. I then started the slow process of bringing the bullet to the bullseye, one direction at a time. To show what I mean, let's say the bullet hit six inches low and eight inches to the right. I then turned the windage adjustment a few clicks to move the bullet to the left and immediately fired a 3-shot group. I continued doing this until the bullet impacted directly under the bullseye. Next, I started the upward movement, shooting a 3-shot group after each adjustment until I had the bullet in the bullseye.

Today, I find it difficult to believe I actually went through all that agony, but the truth is the truth. When someone brought a rifle to be sighted in, I suggested he bring along one or two boxes of ammo. It cost more for the shells than it did for my labor.

It didn't take long for me to decide on a better approach. I enjoyed shooting but realized there was no need to fire a group each time I made a scope adjustment. It was a waste of ammo, plus the loss of time waiting for a

My M77 Ruger 284 put 5 shots in an inch, just 2 inches high at 100 yards, for a perfect hunting zero. This is a deadly cartridge on deer-size game.

barrel to cool. I developed a new approach. Normally, I now fired two shots, the second being a check that the rifle was impacting where the first shot hit. If the two shots were close, I estimated the vertical and horizontal distances to the center of the target, and I made full adjustments in both directions before firing another round. If the scope's metering system was calibrated to move the bullet 1/2-inch at 100 yards with each click, it theoretically required 16 clicks of windage and 12 of elevation put the bullet onto the aiming point if the impact had been six inches low and eight inches right.

I use the word "theoretically" because many older scopes did not meter precisely. It wasn't unusual to turn a metering wheel several clicks and find that no change had been made. Also, some adjustments were accurate for a half-dozen or so clicks and then lost all semblance of reliability.

I had been told that only a fool or an optical expert would disassemble a scope. I felt I didn't qualify for either category, so I had no way of finding out what was taking place inside the tube when a scope was inconsistent. It was evident that the metering system was not responding properly, and this probably was caused by inaccurate or worn parts, weak springs, or just a lethargic metering system. I did what I could with the adjustments and mounts, and kept shooting until all was lost or I got the beast sighted in. I never took up drinking, but running a sight-in range made it a viable option.

There is no point in firing lots of shots moving the bullet toward the bullseye. Get to the desired point of impact as quickly as possible. Save your ammo for group shooting after the rifle is sighted in. I explained earlier that a quick way of getting close to zero is to hold dead center in the bullseye and fire, then hold the rifle solidly on the bags with the reticle on the bullseye. Without letting the rifle move, turn the metering adjustments until the reticle is on the bullet hole. I don't consider this one-shot approach a reliable

method for zeroing in a rifle, but it will get the reticle near the bullet's point of impact with a minimum amount of shooting.

I had a close shooting friend who literally preached this method to me for a long time. In fact, he upset several of my customers when he pointed out to them how I was wasting ammo. He claimed one shot was sufficient. According to him, this method was so foolproof there was no need to fire any more shots to check the sight-in. He upset me so much, I finally asked him to keep his mouth shut. In the end, I had the last laugh. After installing a new scope, he apparently blew his "sight-in" shot, or he certainly became confused when adjusting the scope. It cost him a 6-point buck at 200 yards and, much to his chagrin, it was on my range that the sight-in error was discovered; he was a full five inches low and a cartridge length to the left at 100 yards.

If you use this method, for goodness sakes, do some shooting afterward to make sure the point of impact is where you want it. Don't worry about the cost of ammo. Shoot until you are certain your rifle is on target. It's ridiculous to spend a significant amount of money for license, hunting gear and travel and then come home empty-handed because the rifle was not properly zeroed in.

It's surprising how some shooters feel about zeroing in a rifle. More than once, I was asked to just find out where the rifle was hitting — not to sight it in. These hunters just wanted to know where the bullet hit the target paper. They said they would hold off the necessary amount when shooting at game. I couldn't convince them I should adjust the sights so the shots impacted in the black. It's hard to believe, but it happened.

It's been discussed earlier, but make certain you sit at the bench with the feet flat on the ground, the body in a comfortable position with the front of the ribcage touching the bench top just under the nipple, which will put your knees at approximately a 75-degree angle with the rifle. With heavy recoilers, keep the shooting shoulder and head high. This means the rifle will have to be high on the sandbags. Here is where the adjustable seat comes into play. With a non-adjustable seat, the shooter has to increase or decrease the height of the bags for different rifles. The adjustable seat permits the shooter to raise or lower the seat, which in turn raises or lowers the body.

If a shooter is radically bent over the rifle, the back is arched and the shoulder pocket is not square with the buttplate. The rifle smacks into an immovable wall of bone and muscle on the top of the shoulder. When the shoulder is high, the recoil merely shoves the entire upper body backwards. There is another advantage in shooting heavy recoilers from a high position: recoil is distributed over all of the back and down the spine. I allow my upper

body to pivot at the waist. That is why it's imperative to keep the body in a relaxed position. It should move backward to some extent when the rifle fires, as a baseball catcher's hand moves back when the ball hits his glove. This reduces the initial impact. The same principles apply to rifle recoil. Shoot from a rigid stance, and the end result will be a splitting headache and black and blue muscles.

Let's say the first bullet cut a hole four inches high and five to the left. Make the necessary scope adjustments to bring the bullet into the bullseye and fire a second shot. Repeat this process until the rifle is on target. However, this is not as simple as it sounds, and I am not going to leave you out in the cold at this point, since I know problems will arise.

I reiterate that you should make every attempt to be repetitious. From the way you sit at the benchrest to the method of pulling the trigger, replication is mandatory. With that behind us, let's look at what's happening down at the target. Bullet number one landed four inches above the horizontal centerline of the bullseye and five inches to the left of the vertical centerline of the bullseye. Following the calibrations of your scope, which call for a half-inch impact movement with each click, you turn the elevation adjustment dial eight clicks down and the windage dial 10 clicks to the right. The metering wheels of almost all scopes move the same direction you want the bullet to move. But there is no need to be confused because all adjustment dials are marked with a letter and arrow showing which way the wheel must be turned to move the bullet in one direction. To move the bullet the opposite way, turn the wheel the opposite direction.

Unfortunately, things didn't work out as expected, and your second shot cut a neat hole on the left edge of the bull about two inches above the horizontal centerline. Here is where I disagree with the theory of working from just one shot, as it assumes there is no error in the load, rifle or shooter. Since practically every high quality modern scope meters with a high degree of accuracy, which of the two shots is off? At this point, there is no way of knowing. The solution is to fire a third shot. The bullet nearly touches the second hole, which indicates rather strongly that the first shot is several inches off.

This is not worth making an issue over. It's pretty well established that the rifle is printing slightly to the left and several inches high. Make the necessary scope adjustments and fire again. As long as you are hitting the bullseye, be satisfied for now. There's plenty of time for future sessions where you can hone your shooting skills.

There are sound reasons for making that statement. First, don't expect miracles; you certainly enjoy shooting, but it's not your life's work. Give

yourself time to work out a shooting system that will consistently give good results. Secondly, you're not shooting a competitive-type rifle. There is far too much talk today that every rifle should be a minute-of-angle outfit. Few conventional big game rifles will consistently print 5-shot one-inch groups. I have fired thousands of big game rifles from the benchrest, but only a small percentage would regularly make the magic inch. However, the vast majority more than qualified as accurate big game rifles.

Every rifle has a group potential. The more you shoot from a bench, the sooner you will discover what your rifle is capable of doing. No matter how perfect the hold and trigger pull, not every shot will land on top of the preceding shot. When you see an inch of white between the first and second shots, don't despair; keep on shooting. Judge your rifle and yourself by the overall results, not shot by shot. In fact, I'm opposed to studying each shot as it is fired. Many shooters subconsciously try to make aiming corrections then, instead of holding the same sight picture throughout the group.

Keep a cool head while sighting in your rifle. Don't be intimidated by others. Their comments don't matter now and they certainly aren't going to be with you on a McKean County ridge on a bitter December morning when a buck comes pushing through the brush. The outcome then will depend largely on how well you and your rifle performed on the range the previous summer.

After several sessions, your 3-shot groups will become smaller and more consistent, though you will still get occasional flyers. For the most part, that's probably your fault, unless you get similar results with every group. For instance, the first two shots almost touch each other, but the third and fourth sail to the left several inches. Since they too are almost touching each other, what can the problem be? If I had an exact answer, I would not have to write for a living. From what I have learned, this type of problem stems from an overheated barrel, a change in ammo or bullet weights (unknown to the shooter, of course), or the possibility that excessive cheek pressure is being applied to the stock on some shots.

It's easy to get a barrel overheated. Perhaps the first several shots from a 30-06 or 270 Winchester seem to only warm the barrel. It seems reasonable that two or three more shots will not add much more heat. Believe me, the heat from the first two or three shots is in the barrel; it just hasn't reached the outside yet. When you touch the barrel after the seventh or eighth shot and get singed fingers, you wonder where all the heat came from.

Before adjusting the scope, allow the barrel to cool. The problem should be solved with one or two shots. It's not uncommon to get flyers when zeroing in. Some stem from reasons I have just mentioned, but most come

directly from the shooter. One way to eliminate shooter faults is to take breaks. Not only are you allowing the rifle to cool, but you are also cooling yourself off. The pressure of the initial shooting is over. The next time you sit at the bench, your mind and body won't be battling fears and apprehensions. You know you can stay on the paper and, even though the bullseye is fairly large, it's satisfying to see most of the shots landing in the black. Psychologically, that's important to any shooter.

You are far from perfection, but several sessions of sighting in have given you a new perspective on shooting. You have some knowledge of how to shoot from a benchrest, and getting off an even trigger pull is no longer a mystery. A tougher test comes in the form of a 5-shot group. I realize that I have advocated the 3-shot group many times, and I stick with that. However, the beginning shooter will overcome more shooting problems by firing five shots at one sitting. Five and 10-shot groups test the shooter more than the rifle. It's much harder to shoot a 10-shot group than one of five shots. Such groups require more self-control. If the first four shots of a 5-shot group print a jagged hole, it's difficult not to become nervous. A lump swells in the throat and the heart rate increases dramatically. It takes plenty of willpower to remain calm. A 3-shot group, in comparison, is over almost before the shooter has time to be done in by his or her emotions.

A few paragraphs back, I mentioned that the barrel can get overheated. Most hunters know that a hot barrel sometimes will "walk." Technically, this is referred to as "impact shifting." As the barrel gets hotter, it warps slightly. The shooter can't see any change in the barrel, but his target reveals what is happening. After firing thousands of rifles, I'm of the opinion that barrels do not move back and forth as some shooters believe. I think the barrel moves in one direction and stays there as long as it is hot. Here's what I mean.

Let's say a 5-shot group formed well inside a 3-inch bullseye. The shooter wants to see if he can put another five shots on dead center. By the time he finished his first group, the barrel was really warm, and now the first shot of the second string goes to the left. The second shot wanders farther left. The remaining three shots move slightly farther away from center, but they form a decent group. Not knowing what the problem is, the shooter adjusts his scope to bring the group back on the bullseye — which is the worst thing he can do. If he allowed the barrel to cool to normal air temperature after the first group, his second group would have essentially formed right on it. But now, if he doesn't discover his error, his rifle will be shooting to the right when he fires from a cold barrel. This is not a figment of my imagination; I have seen it happen numerous times.

I have written many times in *Pennsylvania Game News* columns that I am more interested in where a varmint or squirrel rifle puts its first shot from a cold barrel than I am in the diameter of a 5-shot group. The first shot does the job on game. This is also important to the big game hunter, but it's not as critical because a deer or bear is much larger than a squirrel or woodchuck. Let me give an illustration.

One of the fanciest 243 lightweight varmint outfits I ever picked up was built on a Mauser action. It sure had the looks, but it didn't see much service in the pasture fields because it had the nasty habit of tossing the first couple of shots about 1½ inches from dead center at 100 yards. It wasn't consistent in picking the direction, either. Usually, the second or at least the third shot made it back to center, but that didn't help my average on chucks. It was a classy looking outfit, and I was determined to lick the problem. I did some minor stock relieving, which didn't help. Finally, I had it glass bedded, thinking that stiffening the stock and obtaining an intimate metal/wood relationship would solve the problem. I was wrong. That was my first concrete evidence that glass bedding is not a panacea for all shooting ills. Much fuss is made over reinforcing a stock with fiberglass, but it is a last resort as far as I am concerned. I can't say what was wrong with that 243, but somewhere during the steel making and barrel drilling process, a glitch apparently worked its way into the barrel. I finally gave up on that rifle and sold it to a deer hunter.

Squirrel and varmint hunters should always use rifles that put the first shot from a cold barrel on target. That might not be critical with a big game rifle that's used in the woods, but every hunter should know where his first shot from an unheated barrel will go. If the problem is severe, a gunsmith should be consulted. If it's minor, live with it. Don't dispose of a big game rifle because its first shot is an inch or so offcenter. And don't discard it because it you can't get groups much below 2½ inches at 100. That's still a good hunting rifle. Don't be lulled into believing everything that's written about groups. Some of it is misleading.

Believe me, a group is more than just the distance between the two widest holes. It's a story in itself.

Group Anatomy

A GROUP, IN shooters' terminology, is a number of shots fired with a handgun or rifle at a known distance at a stationary target. The objective is to put a given number of shots in as small an area as possible. For some reason unknown to me, groups are fired in strings of 3, 5, and 10 shots. The group is then measured, and its total diameter, center to center of the two widest shots, reveals something of the grouping potential of the rifle.

Nowadays, most shooters who want to check out a rifle and/or load normally settle for one or two 3-shot groups. A 5-shot groups gives a truer picture of the combination's potential, and a 10-shot string is fairly demanding of the shooter, rifle and load.

Group shooting should not be done in a haphazard manner. The same approach must be used when firing a group with a varmint or big game rifle as is used by a benchrest competitor. You won't get a benchrester's results but, if you do everything in a consistent manner, you'll get the best from yourself and your rifle.

Overheating the barrel is the most common mistake made by non-competitive shooters. While the barrel is heating up, there is not always much impact shifting or barrel walking. In some rifles, I have been able to fire a quick string of five without seeing any shifting on the target. However, the best approach is to space the shots one or two minutes apart. This takes time, and on a 10-shot string, it seems to be forever. That's one of the reasons I stick with the 3-shot group. I can fire three evenly spaced rounds, take a ten minute break, and go back to shooting. Maybe I'm using just as much time, but the period I'm away is relaxing, while sitting at a bench waiting for a barrel to cool makes me nervous. Take a break, and get your mind off shooting.

This may sound a little unorthodox, but we are often defeated at

the benchrest before we fire the first shot. We tend to put all the emphasis on group measurement. Everything seems to rest on the distance between the centers of the two widest shots. While this is one method used for rating competitive groups, I feel it's wrong for the average hunter.

Out of the million-plus hunters in Pennsylvania, only a small percentage fire their big game rifle more than 20 times a year. This is understandable, as the big game seasons here are relatively short. Big game fever hits most hunters when the first snowflakes fall in late October or early November. Time is a factor, and the days are shortening at a rapid pace; practice sessions will be few and crowded into a short time span. If the hunter didn't get in a little woodchucking with his big game outfit, there's a good chance he hasn't fired it since the last big game season, if then. It's unfair to expect this person to sit down and fire a 1 1/2-inch 5-shot group, no matter how accurate the rifle might be. My benchrest is inside my shop, and I can shoot at night or in any type of weather. Yet, when several weeks slip by that I don't do some shooting, I have to go through a readjustment period. I reiterate — don't expect miracles during the first sessions.

When you finally close the action on a live round and plant yourself firmly at the bench, keep these things uppermost in your mind: you do not have to perform like a champion, you are not shooting a competitive-type rifle, and the size of a given group is not always a true indicator of how you and your rifle work as a team. A big game rifle's effectiveness should not be judged solely by the distance between the centers of the widest two holes.

This have been proven to me hundreds (not exaggerating) of times. Here is a sample. I was pasting targets on my 50-yard range board, when a man carrying a scoped rifle approached.

"Want to buy a rifle cheap?" he said with a smile. "Keep in mind it's not accurate beyond 30 yards."

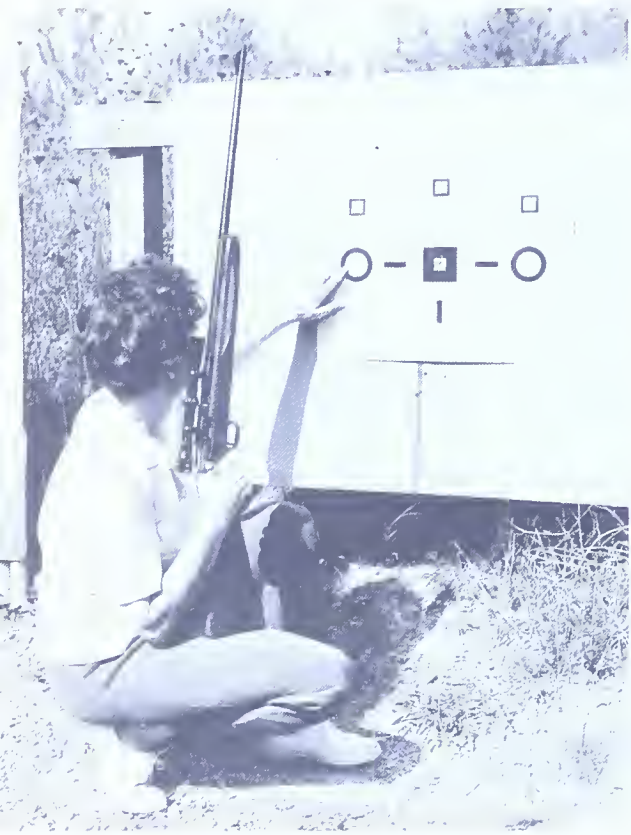
"What's wrong with it?"

"Won't shoot straight," was his quick answer. "If you don't believe me, I'll show you," he replied, waving a roll of paper under my nose.

By this time, we had walked back to my chronograph bench, and he proceeded to remove a target from the paper roll and flatten it out on the bench. I had no idea what he had in mind, and there wasn't anything dramatic about the target. I counted five holes in a large bullseye, but it was just another target to me.

"Take a close look, and you can see this outfit is a top candidate for the junk heap. See how it scattered those shots? Here are several more targets that back up what I'm saying."

I complied with his wishes and looked more closely at the target. I was



Helen examines a 50-yard group fired with her Browning T-Bolt, 4x Redfield. When a light 22 rifle shoots like this, it's hard to understand why it was discontinued.

holding a roll of masking tape in my hand, and I placed the roll on top of the group. Four holes were well inside the center opening, which I later found to be an even three inches in diameter, and one hole was under the tape.

"I don't see anything wrong with your group," I said after a few seconds of study. "Four of the five shots are under three inches. In fact, three of those four shots could be covered with a half dollar. For a lever action rifle, that's laying them in."

"You have to be kidding," he said in exasperation. "I thought you knew something about shooting. That group measures close to four inches center to center of the two widest shots, and you're telling me it's good shooting."

"Wait a minute. You're concerned only with the group's extreme measurement, but if you take a closer look, you'll discover that no shot was more than 1¾ inches from dead center, according to my machinist rule. There's more to the story than just what the two widest shots tell."

"I don't follow you," he cut in. "When a rifle scatters its shots over four inches at a hundred yards, I'm ready to give it away. I wouldn't want it on my conscience that I actually took money for it. What deer hunter in his right mind would want a rifle as inaccurate as this one?"

"I'll take in any day you want to give it away."

My quick reply startled him, and he gave me a quizzical look, not knowing for sure just what I was up to.

"Are you serious?" he asked.

"Just like I told you. There's more to a group that the distance between the two widest shots. I agree the results aren't impressive by varmint rifle standards, but a conventional big game rifle shouldn't be judged solely by its extreme spread. That's misleading in many cases. Another thing, you're

putting all the blame on the rifle, but some of these groups suggest shooting or reloading errors. Look at the vertical stringing on that one target. Many times that's caused by erratic ignition. If it happens consistently, change loads or check to see if the primer you're using is the one recommended in the reloading manual. Long shot strings or splattertype groups are often the result of improper holding or a variety of other shooter mistakes such as mixing brands or ammo or bullet weights."

"What's your analysis of the first target I showed you?"

"My ruler says that groups measures just about 4 inches center to center of the two wides holes. That may sound bad, but take a closer look. Three of the five shots have very little white paper between them. One shot is less than an inch to the left of the cluster. Actually, those four shots are in roughly 2¾ inches. One more inch beyond the wide shot is another hole. If I'm correct, the widest shot was your first one."

"I believe you're right, but how did you know that?"

"Simple. The barrel walked to the right as you shot. It reached its destination after the second shot and remained there while you fired the last three. If you made a sight correction after this shooting to move the group back to the left, the next shot, from a cold barrel, would be far to the left. Your first shot in this particular group impacted where the rifle was sighted in. It walked to the right as it heated, but as soon as it cooled it would be back on center."

"You're telling me that sitting at a bench and firing several 5-shot groups in a hurry is not the way to sight a rifle in," he said thoughtfully. "Here, this is the target I fired before coming to see you, and the group is to the left of the bullseye. I felt it was more proof that the rifle was inaccurate. Maybe I don't have such a bad rifle after all."

Some years back, I cranked out an article about reading groups from a hunter's point of view. One of the points stressed was that the hunter and his big game rifle are not shooting competitively. It's unfair, and not even logical, to decide the fate of a big game rifle by using benchrest measuring methods. The benchrest shooter fires a well-tuned extremely accurate rig. On top of that, he must be skilled in every aspect of competitive shooting, from reading mirage to setting off a 2-ounce trigger, because a few thousandths of an inch is often the difference between winning a match and second place. Neither the hunter nor the big game rifle is in that class and can't be expected to perform to the same high degree. Why should the same measuring system be used?

If we look at this logically, it's apparent that a factory produced big game rifle never was intended to perform on equal terms with a competition outfit.

The tolerances in mass-produced rifles vary considerably from rifle to rifle. Also, trigger setups can run the gamut from decent to poor. None would qualify for bench competition but, here again, there's no need for that type of trigger on a hunting rifle. While tolerances may vary and many trigger setups are not clean and precise, the fact still remains that today's mass produced rifle is more than adequate for the big game woods.

It's also unfair to expect a hunter to shoot on par with a benchrest competitor. For most of us, shooting is a pastime, not a semi-profession. I am not denigrating the average big game hunter by saying most aren't psychologically adjusted to consistently fire tight groups from big game centerfire rifles. Recoil and muzzle blast take a heavy toll, and getting off a smooth, even trigger release with a factory produced rifle is an art that can't be learned in one or two practice sessions. The tight group is rarely a product of luck; accuracy is made. Accuracy is obtained by adhering to fundamentals while using an accurate rifle, top quality scope with target-type reticle, and consistent ammunition. A shooter who knows how to properly blend all these ingredients shot after shot produces small groups.

My term "group cluster" is relatively new in the shooting fraternity, so far as I know, but it's what the hunter should look for in a group, instead of being totally concerned with the two widest shots.

I was recently shown a 5-shot group fired from a Model 700V Remington 6mm heavy barrel, topped with a Redfield 6-18x scope. It was an odd-looking group. In fact, there were two 2-shot groups and a flyer. Two shots touched at the left of the centerline of the bullseye, two were nearly touching more than an inch to the right, and one shot was low. The new owner, who had purchased the rifle primarily for long range chuck shooting, was downcast, and that's an understatement. He moaned that at 400 yards he wouldn't be able to hit a 50-gallon drum.

Without checking anything, I fired three shots. A baseball would have been hard pressed to cover the group. Something was seriously wrong, and I decided to remove the scope and start with the base screws. To my surprise and his humiliation, the rear hole of the Redfield base was empty. He had overlooked installing the screw. When that was taken care of, the rifle performed like a champion.

That was the only time I've ever seen that particular goof. However, I have corrected a lot of group problems by simply tightening base screws, ring clamp screws, and even stock screws. Many times loose stock screws come from failing to retighten them after a new rifle has been fired several times, or after the stock has been removed. When an action has been taken from the stock it might not fully seat itself until three or four shots have been fired.

Also, a rifle that has not been fired for a long time should have the stock screws checked. Expansion and contraction due to temperature changes can loosen things somewhat. Stock screws should be checked before each sighting in session. Here's an example.

A fellow handed me a rifle that was giving poor results. He explained in detail how he had gone over every screw in the mounting setup. He felt certain the barrel was shot out or the scope was defective. I fired a 3-shot group which showed something was out of whack. When I gave a gentle tug to see how much pressure the forearm was exerting on the barrel, the stock and barrel separated by an eighth of an inch. The front guard screw required a full turn to seat the barrel in the stock. When I tightened both the front and rear stock screws properly, the problem was solved. These two incidents may sound unusual, but all screws are prime suspects when a rifle performs erratically.

Today's mass produced big game rifles are accurate. Far more so than the prewar outfits that are now so steeped in nostalgia. There's a reason for this. Rifle manufacturers are producing much better barrels today than they did forty years ago. Bullets are also far superior to those of Depression years. A lot more emphasis has been placed on accuracy during the last four decades. Computer controls and robotic machining produce unbelievably close tolerances. The end result is a more accurate outfit.

In the early days of benchrest competition, a top shooter could outshoot the rifle. That's not true today. It's the shooter, not the rifle that is the limiting factor. To my way of thinking, the same holds true with the big game outfit; few hunters can outshoot their rifles.

The wisest approach for getting top results during practice sessions and in the woods is to stick with a cartridge that doesn't produce severe recoil. But don't expect miracles. Allow time to get adjusted to bench-type shooting. Always check the first shot from a cold barrel. It's imperative to know where a rifle puts this shot. You don't get warm up shots when a buck comes sneaking through the brush. However, it's not a good policy for most hunters to check the target after each shot; some shooters subconsciously make aiming changes after studying a target, and that unaccountably alters results. Number and date each target. Enter such things as temperature, wind conditions, type of ammo or components used, especially bullet weight, and whether the target was fired from a hot or cold barrel. These things may seem insignificant but they aren't. No one can remember such data over a period of months. Dated and numbered targets do, and I'm not afraid to bet that the higher number targets will have smaller groups.

Sighting in a big game rifle shouldn't be taken lightly. While the average

shooter doesn't have to know all of the benchrest techniques, the big game rifle shouldn't be tossed haphazardly on a couple of sandbags and fired until an egg could be cooked on the barrel. There's no argument that less-than-inch groups will never flow freely from a Model 70 Winchester Winlite 30-06, 300 Savage M99, Ruger M77 308 or a 280 Remington 700 Mountain rifle. In fact, of the thousands of conventional big game rifles that crossed my bench over a 15-year span, I have enough fingers and toes to count the ones that would consistently put five shots in a 3/4-inch group at 100 yards.

I hope that statement might shatter the belief that a big game rifle isn't worth owning unless it will print the magic minute-of-angle groups. Truth is, that accuracy potential is beyond the reach of the vast majority of hunting outfits. Why should such accuracy be needed in the big game woods anyway? Actually, it isn't, and it's a waste of time and ammo to strive for such unlikely results. The minute-of-angle syndrome has done a great deal of harm to thousands of big game rifle enthusiasts. Unfortunately, that is the criterion used, and it's really a shame.

I'm not implying that the hunter should be satisfied with 3- or 4-inch groups if his rifle can perform better. But the results will then depend on him. The shooter who can carry out all the holding requirements, read the mirage, allow for wind, and time the trigger release may not get one-holers, but the rifle will look like a winner.

The ultimate goal is to become consistent. Firing a string of five 3-shot groups of 2 inches or less definitely proves the shooter is doing everything right. If a shooter is consistent at cutting even 3-inch groups at 100 yards, there's no reason to relegate the rifle to the ranks of the unwanted. Three inches might sound bad, but it will still put every shot in the bottom of a 3-pound coffee can at 200 yards, and no deer will walk away from that type of shooting, whether the hunter aims at the ribcage, shoulders or neck.

The vast majority of hunters, including a large percentage of successful deer hunters, are not highly skilled marksman. When we drop a deer or bear, we automatically assume the kill is a result of good shooting, but that's not always true. The vital area of a deer is a large target, perhaps more than a foot square. Since most deer are killed under 150 yards, it doesn't require great shooting ability to hit it. Few hunters are sure before they look at the dead animal where their shot struck. I tell my old hunting friend Bill Nichols that as soon as I find out where the bullet hit, I will tell him where I was aiming. The average successful hunter will find there is a vast difference between woods shooting and range practicing. It's a different ball game.

This will become apparent at the benchrest, but mediocre results shouldn't be discouraging. Keep at it, and you'll improve. I'm a firm believer

that what is learned at the bench, plus some offhand practice, will ultimately make any hunter more successful. The only way to become proficient is to shoot as much as possible. I know a handgun competitor who fires a box of ammo almost every day. In fact, he built a 15-yard range behind his garage. He is an excellent shot, but claims the only way he can stay in top form is to shoot every day, winter and summer.

Shoot until you see concrete results on the 100-yard target, less than 3 inches, say. Once you reach this plateau, big game hunting will take on new meaning, and will be much more effective. This may take some time, so have faith in yourself. You must believe you can shoot consistent groups. It's not how small the groups are; the important thing is that each group is close to the same size.

It's important for every hunter to believe that this type of shooting is not beyond his capabilities. Every hunter possesses this potential. I have seen dozens of hunters discover the joy of practicing. Some had twenty or more years of frustrating hunting experiences because no one had taken time to

Successive groups show how Darrel changed his scope to get zeroed. First shots were high and left, next two were within inches of desired zero, final 5 were dead on. The hunter has complete confidence in a rifle zeroed this well.

show them how to shoot. They did not have any idea how to sight in a rifle or shoot a group. They had assumed good shots were born to be good shots, and bad shots were hopelessly lost. That's not true. Good shots are made. Accuracy is the end result of applying certain fundamentals. I have taught women who never fired any type of firearm to become super target shots. In fact, it is easier to instruct a person who has absolutely no knowledge of gun handling than it is to teach someone who has a host of bad shooting habits to overcome.

I often asked new shooters why, if I had confidence in them, they had no confidence in themselves. It's just fear of failure. No one wants to make a fool of himself. They believed successful shooting was far beyond their ability. I can think of no better way to close this chapter than by relating an episode from 1963. It will prove my point decisively.

A middle-age gentlemen brought a 300 Savage M99 to have a Leupold 4x scope installed in a pair of Leupold Detacho mounts. I drilled and tapped the rifle and mounted the scope without any problems. He had brought a box of ammo, and I used five rounds to get the rifle dead on at 100 yards, as per his request. The rifle was ready for the owner to test.

When this man, who was a highly successful businessman from a distant city, came to get his rifle, I fired a 3-shot group to show him it was hitting where he wanted it. I then suggested he shoot several rounds to see if he was satisfied. To my amazement, he refused. He told me he was the laughingstock in his deer camp, and the butt of some very humiliating jokes. In close to two decades of hunting out of that camp, he had killed one deer — which he had been assured was pure luck — and had missed over a dozen bucks. He almost always saw legal deer, but was such a poor shot that he knew when he started to shoot he was wasting his ammo.

I found it difficult to believe that such a fine gentlemen had received such treatment over such a long period. I made up my mind he wasn't leaving until I made some type of effort to help him. It took some convincing, but he finally sat down at the bench with his Savage 99. I explained how to hold the rifle square on the bags and pull the stock into the shoulder pocket. It was time for the first dry fire shot. To say he flinched is an understatement. He literally closed his eyes and yanked the trigger. But ten minutes later he was pulling evenly on the trigger while holding a steady sight picture. The click of the firing pin falling didn't make him flinch. When I suggested switching to live ammo, he said enough was enough, he wasn't going to look foolish in front of me.

I insisted he shoot. I pushed several shells into the rotary magazine and levered one into the chamber. Then I placed my hand on his shoulder, telling

him to hold steady and pull evenly. I'm certain the rifle went off when he wasn't expecting it, and the spotting scope revealed a hole on the edge of the 4-inch bullseye. He couldn't believe he had hit the target, let alone touched the bullseye.

The second attempt hit a bit to the right, and I explained that he was pushing the stock with his right hand. His third shot landed in the black. He was amazed at putting three shots in an area smaller than his ammo box.

We took a short break, while I went over some of the basics with him. He had fired a 3-shot group that was less than five inches in diameter, but I insisted he could do better. A few minutes later he fired the remaining shells and, if I recall correctly, three landed in the black. He was a new man. He assured me he would take my advice to practice as much as possible before the season, and that he would enter the deer woods with new confidence, now that he knew he could shoot.

What does this have to do with group anatomy? Well, it wasn't a case of the two widest shots, it was the revelation that he was capable of putting his shots into the same area. He assumed he couldn't hit anything, and his so-called hunting friends had let him suffer under that delusion for two decades. Forty-five minutes of instructions and firing a dozen rounds ended twenty years of frustration and humiliation. It was a great day for me, too.

A group is more than a bunch of holes, and it reveals much more than just how much distance is between the two widest holes. I am always aware that the unexplained flyer is probably my fault. I first blame myself, and that's doubly true when using top quality handloads or factory fodder in a proven rifle.

One group tells very little. A half-dozen or more groups begin to tell a story. Cutting bullet holes in paper is not a waste of ammo. A compilation of groups is a revelation of how well you and your rifle perform. Knowing what a group really shows will cut down on the silliness of judging your rifle and your own shooting abilities just by the distance between the two widest holes.

Metallic Sights

FOR SOME REASON my mind is always trying to recreate how an item like a trigger, safety or sighting device came to be. I have a natural curiosity that keeps me wondering just how many years, people and failures it took to bring something to fruition. Some things, like the rifle scope, can be pretty well traced to a starting point. Documenting the history of the iron or open sight presents a different story. We know for certain that they came into being after the cannon was invented, but to pinpoint the exact time sights were installed on shoulder weapons seems impossible to establish.

Maybe I better clarify what the "sight" I'm referring to means. Sights or aiming devices had been in use by mankind for centuries before gunpowder was invented. Surveyors used "sighting points" for running boundary lines or laying out buildings. The exactness of their work definitely shows they had some means of running "true" lines over long distances. If you think there is nothing to laying out a large building, watch a surveyor, using a modern transit, square a foundation for a house. It's a bit more complex than meets the eye. Any mason or bricklayer can attest to that. It boggles the mind when we look at some of the massive structures built in the days of the Biblical kings and pharaohs.

In construction and surveying, to run a true line, a two-piece sight was used, and there's little doubt the "surveyor's" sight was carried over to the crossbow. Early crossbows were made of various materials from wood to whalebone. As they became more sophisticated in throwing their quarrels or bolts accurately it doubtless became obvious that a sighting device would make them more deadly. After the hand cannon was replaced with a viable shoulder piece, the next logical major development would be some type of sighting arrangement.

Firearms history doesn't reveal too much about early sighting devices, but

they were probably nothing more than one or two metal pins attached to the barrel. The hand cannon was so difficult to fire there was little need for a sighting arrangement. That doubtless changed in a hurry when the shoulder weapon developed enough to hit a single object with reasurable consistency. The cannon was not aimed precisely; it was more or less pointed in the general direction of the enemy. It might have been aimed to some degree at large objects such as walls or entrenchments. The shoulder weapon put war on a different level. The magnificent knight had been the terror of the mud soldier who probably was armed with a club, pitchfork or homemade spear. The powerful, well-trained mounted knight had little to worry about — that is, until the shoulder weapon hit the scene. He had plenty to worry about then.

The shoulder weapon really made all men equal. Perhaps the Spanish author Miguel de Cervantes summed it up best when he lamented that guns were the Devil's invention and that even a coward could now take the life of the bravest knight, or words to that effect. The infantryman, who once crouched in fear when he heard thundering hoofs, could now stop his foe long before the knight could use his lance or swing his battle-ax. It was evident that the methods of war would have to change.

As the shooter became more efficient, there had to be a strong demand for a more accurate shoulder weapon. Accuracy is a two-fold product — it requires good shooting and a good rifle. Through the 16th and 17th centuries, there was no real demand for sights, possibly because they wouldn't have done much good anyway. Occasional old drawings give the impression some early military weapons had a front sight, but historians generally agree that what looks like one is actually part of the bayonet retaining device. Still, I'm certain as rifles improved, sighting arrangements did too.

I can't go into detail on the evolution of the various sighting devices that appeared over the years. One thing is certain, there had to be an intense interest in sighting arrangements as some very old rifles carry impressive adjustable sights. Even while the iron sight was being perfected, work had already begun on the magnifying sight. I have written several times in *Pennsylvania Game News* about Sir Isaac Newton, of law of gravity fame, using an optical sight for long range shooting. That was around 1700, and there's no evidence that Newton was the inventor of the optical sight. Apparently, the use of a magnifying scope was an honest attempt to improve the shooter's ability to see the target. While there is disagreement on dates, there is no doubt the iron sight was born a number of years before the telescope was modified to fit a rifle but, contrary to popular belief, the

adjustable iron sight didn't appear too many years ahead of the optical sight.

Very early open sights undoubtedly were of the fixed type. There was no way of adjusting them. As shooting skills improved, both the military and the hunter realized there had to be a means for adjusting the sight, especially for elevation. I have often thought that the first time a gunsmith made a change to raise the point of impact he probably raised the front sight and, to his surprise, found the rifle shot lower instead of higher. That is pure speculation on my part but, from the hundreds of open sights I have installed or adjusted, I know that many shooters wanted a higher front sight if their rifles were shooting low.

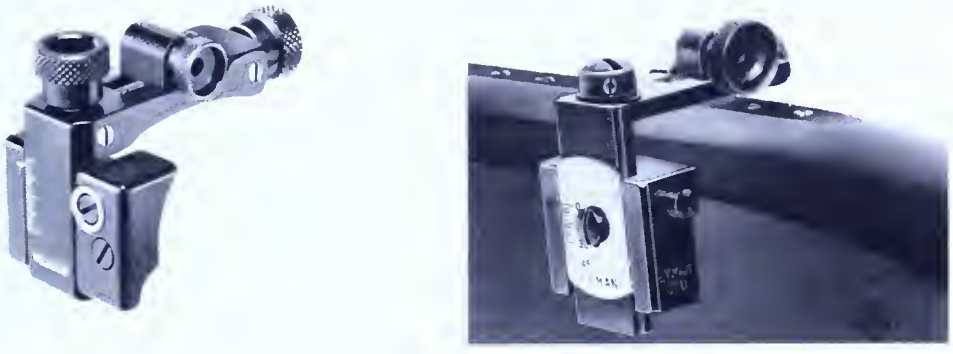
When the two-sight arrangement appeared, it probably didn't take long until a method for adjusting both windage and elevation was in common use. I have seen very old rifles in museums that had precise adjustable sights. Even the aperture or peep sight was used in the late 16th century.

The more I delved into the sight subject, the more convinced I became that a great amount of attention had been given to various sighting arrangements. Form the designs I've seen, it's evident some early craftsmen understood something about the invisible flight of the bullet. The demand for better efficiency led to the fine-threaded adjustable sight of the 17th century. It didn't just happen; it was designed and then built by skilled craftsmen.

A decade or two before the Civil War, the adjustable sight was winning a lot of converts and, by the time our nation was engaged in that terrible struggle, both the military and the serious hunter knew the benefits of the adjustable sight. Taking Kentucky windage — deliberately holding off the desired point of impact to compensate for sights that did not align with the bullet's path — was no longer a skill the apprentice shooter had to learn; the adjustable rear sight solved the problem of zeroing in.

The oldest sighting arrangement probably was a simple V-type rear sight and a blade-type front. Countless muzzleloaders had this arrangement. I remember examining one rear sight that had been painstakingly fitted into a square hole cut into the barrel. Apparently, the dovetail principle was not known to that gun builder. Also, the front blade was fitted into a longitudinal cut in the barrel. There was no way to make any adjustment. However, everything must have worked as there was no sign of the sights being tampered with. It was a terrific job of centering.

The V-type rear sight never died. It lives today in one form or another. The blade front sight still lingers on but, for the most part, it has been replaced by a bead or ramp-type sight. Most of the changes in metallic sights have been in the rear one. The simple V notch was long ago modified into a full U, a semi-buckhorn, a full buckhorn, and other variations. No matter what altered



Williams Foolproof receiver sight, left, and Lyman 66U are excellent for big game hunting at reasonable ranges.

shape the V takes, it still remains in the category of the open sight.

There is a problem with the V-type sight. In fact, there are two problems. The first deals with the limitations of the human eye, the second with the aging or weak eye. Let's take a quick look at the first, since the second is self-explanatory.

With a V-type sight, the eye has three aiming points to align — rear sight, front sight, and target. The eye is unable to focus at three different distances at the same time. To correct for this, the eye's focus must shift back and forth rapidly from one to the other. This requires extremely fast adjustment of many eye muscles. Young eyes handle this rather effectively, but it's a serious problem for older ones.

The aperture sight eliminates one of these factors — the shooter simply looks through the hole without focusing on it — but there are still two focal points, and the eye is still hindered by the focusing problem. Right here I can make a personal comment on the eye dilemma. When I zeroed in thousands of rifles during the 1950s and '60s, it made little difference to me if a rifle was equipped with a scope or metallic sights. When I say metallic sights, I'm referring to all non-optical sights, open or aperture. At 100 yards, I could line up any kind of sights on a 4-inch bull without blinking an eye, and that's not a pun. Today, a third of a century later, about all I can do with iron sights is blink. I don't want to get into scopes here, but the so-called weak eye's answer comes wrapped in the form of the optical sight.

Today's rifle manufacturers don't seem concerned with the quality of the open sights on their products. I've been told by people in the top ranks of several gun companies that there is a perfectly good reason for this. They claim today's rifle will have a scope installed at the time of sale. So why

bother to provide high quality metallic sights that will end up in a small plastic bag in a drawer of a gun cabinet. After installing well over 2000 scopes, I can attest to the logic of that thinking. I used many a small plastic bag for the discarded open sight, and tied it to the trigger guard.

I can see the manufacturers' point, but I am not convinced it is entirely proper. Many rifles are offered without open sights for those who know they are going to have a scope installed. That keeps rifle production cost down a bit. From my own point of view, it would matter little if open sights were completely discontinued. But I have to be more fair than that. First, not every hunter wants a scope. Thousands of shooters are just as precise at 100 yards with good iron sights as I am with a low power scope. They deserve better metallic sights from the factories.

Maybe I should give an illustration of what I mean, and I also might add that mentioning aging eyes was not meant to be derogatory to older shooters. In my book, deteriorating eyes are weak eyes, not necessarily old eyes.

The Saturday night before opening day of buck season never failed to be frustrating, sad to some extent, and filled with surprises. Surprises like the fellow who wanted me to drill and tap his rifle, mount the scope, bend the bolt handle to clear the scope, install a low-swing safety and sight the rifle in — in time for him to pick it up on his way to camp the next morning. He left two minutes after he arrived, muttering something about "people who didn't want to work."

On another Saturday night, an aged hunter stopped to see if I would sight in his new Model 70 Winchester 30-06. He assured me he would be back after buck season to have a scope installed. My eyes were still fairly sharp then, and I soon got the rifle into the 4-inch bullseye. When the old fellow asked to take a shot or two, I obliged, after assuring him I had done a pretty decent sight-in job. I figured he would be fortunate to stay in the 18x22-inch window in the target house.

I watched through the spotting scope, wondering all the time how much wood would be blown off the window edges, but my fears never reached fruition. His first shot touched my last shot, and his second shot nearly made a cloverleaf. He asked if I could move the adjustment just a "bit" to the left so he would be in dead center. I was silent as a week-old mushroom. I made the adjustment and watch in admiration as the elderly shooter fired two shots that touched the one-inch white square in the center of the black 4-inch bullseye.

He thanked me profusely for sighting in his rifle, and you know in advance I didn't touch the $5 he offered. I asked him why he wanted a scope when he could shoot like that with irons, and he replied it was not for him,

Williams Guide open sight is adjustable for both elevation and windage, with reliable reference marks. Right, a Williams Sight Pusher makes it easy to move front sight if necessary.

but for his grandson, who would get his rifle and scope for a birthday gift after buck season. It seemed the grandson was going to be 16 on the same day the old fellow turned 79. That revelation put my left foot farther under my lower denture. I vowed never again to let silver hair and stooped shoulders make me think of aging eyes; that old gentleman had the eyes of a teenager, and he could really shoot.

Another unforgettable incident proved beyond a shadow of a doubt that many hunters really do want top quality adjustable open sights. The rifle was a very neat custom 222 with a high quality 10x target scope. The owner wanted to swap the scope for a No. 48 Lyman aperture rear sight, installed and zeroed in with his ammo. At that time, the list price of the No. 48 was around $12.50 plus the time needed to drill and tap the action. The scope was not new, but it was worth far more than the total of the sight and installation.

I explained this, but the man was not interested in the scope; he wanted a high quality peep sight. He admitted a scope had certain advantages, but he felt confident on chucks up to 200 yards with aperture sights. Just to keep my conscience clear, I told him again he was getting the short end of the deal. He came right to the point: Did I want to do the job or not? What could I say? So I installed a new front bead that better matched the Lyman 48 and did the preliminary shooting to get on the paper, then he zeroed the 222 two inches high at 100 yards, getting an excellent group. There was no question that this man knew exactly what he wanted, and he also knew how to shoot. The episode further convinced me that not every hunter will take the scope route.

I don't want to get off the track, but I have always felt there are two types of eyesight, especially in the hunting fraternity. There's what I suppose is normal eyesight, and there is what could be termed "woods eyesight." My

friend Bill Nichols wears glasses, which indicates to some extent that his eyes are not as good as they once were. But he can see the rump or the back of a deer at 200 yards in the woods. He doesn't need snow, either. In other words, Nichols knows what to look for. What might look like a vague spot or a battered stump to most hunters is often a deer to Nichols. He's seldom wrong.

In my early woodchuck hunting career, I didn't need binoculars to spot chucks at normal varmint shooting distances. My late father-in-law, Darrel Nulph of Bradford, claimed I had telescopic eyes. When he and I were driving the back roads around Farmers Valley, I would often point out a distant chuck. Sometimes it was only a black spot, or just the head sticking above the grass. After parking, Darrel would shade his eyes and stare for maybe half a minute. Finally he would check it out with the binoculars. If I were right — and I usually was — he would just shake his head. I did have good eyes, but I also knew what to look for.

The "woods eye" doesn't materialize from how strong the eye is, but from experience. The "hunter's eye," as some call it, can't be measured by optical instruments. In other words, to have good woods eyes, you don't have to have super vision. But it might be interesting to know what we can expect from the normal, healthy eye. In discussing this with an optometrist, he gave me some facts and figures that probably mean little to the average hunter and shooter. I'll try to put his information into general terms.

It's worth a few lines to discuss just how much resolving power the human eye has; that is, how much detail it can see without optical help. I know I can't see as well as I could twenty-five years ago. I also know there are shooters like the elderly gentleman mentioned a few paragraphs back who have retained powerful eyesight over a long period of time. So what is normal? Numerous tests over a long period of time have indicated that under optimum conditions the human eye can resolve about one minute of angle. That is, it can differentiate between two contrasting objects if they are at least one minute of angle in size and are separated from each other by that distance. Eyes which can do that are considered normal. But that leaves the question, what is a minute of angle? That's a term which is used constantly in shooting, particularly in sight adjustment, but it actually is a very precise measurement. It is based upon the plane geometry definition that there are 360 degrees in every circle. A circle is a curved line on a plane surface, each part of which is equidistant from a given point, its center. Therefore, each degree of that line is 1/360 of its length. By further definition, to obtain smaller and often more useful measurements, each degree is divided into 60 equal parts called minutes; thus, each circle contains 21,600 minutes (60 x

360). The distance between the points where two adjacent straight lines from the center of the circle intersect that circle is known as a minute of angle. This measurement of course is proportionate to the distance from the center point; it will be twice as great at 200 yards as at 100, etc. As things work out, it happens that the measurement at 100 yards is very close to one inch — 1.047, to be precise — which is very convenient because so much of our measuring is done in inches, including that which relates to bullet trajectory, micrometer sight adjustments, etc. In the end, although it isn't completely accurate, shooters have found it practical to assume that one minute of angle equals one inch of lateral measurement per 100 yards of distance, or "one inch per 100 yards."

I can assure you it takes a darn good eye to resolve a one-inch object at 100 yards. My mailbox is 290 feet from my office window. I placed a one-inch orange target square on the black pipe post and, even though I can see it at that distance, there is no way I could aim at it with open sights. When I discussed this with several veteran match shooters who shot impressive rimfire rifle scores in the 1930s with aperture sights, they claimed it took better than a 1¼-inch group to win a match. If that's the case, the best groups would often be an inch or less.

Since the iron sight — and I'm basically speaking about the V or U-type rear and the bead or blade-type front — had its heyday from the flintlock era until shortly after World War II, I dug out a 1931-32 "Arms and Ammunition" catalog from A. F. Stoeger, Inc., a 1901 gun and accessory catalog from T. M. Roberts Supply House, Minneapolis, Minn., and the 1903 A. J. Rummel Arms Co. catalog. I wanted to see what types of iron sights were available back then. Don't think for a moment that shooters in those long-gone days didn't have some sophisticated sights.

Leafing through the tattered pages, it became obvious that shooters of the early 1900s had an impressive selection of metallic sights to choose from. In the T. M. Roberts catalog, Lyman featured a variety of peep and leaf rear sights, including the folding tang aperture sight we still see on many Savage 99s today. There was no shortage of front sights, either. There were many ivory beads, knife blades, and a folding combination front sight which was a post-type ivory bead encircled by a globe. The globe could be folded down so the bead could be used in a conventional manner. Another front sight that caught my eye was a wind gauge sight with a spirit level.

Even in 1901, some rifles boasted the Lyman multiple folding leaf rear sight. The Model 113 had two folding leaves. One leaf was a horizontal rectangular bar with a triangular ivory center, the other a wide open V crotch. Why would any shooter want a rear sight that consisted of a plain

uncut bar with an ivory triangle in its center? This perfectly reasonable question has a perfectly reasonable answer. Shooters of that era weren't governed by regulated shooting hours. Many old-time squirrel hunters hit the woods long before daylight and stayed until the moon peeped over the horizon. I'm not suggesting those are the best times to hunt squirrels, nor do I want to say that design was a night-type sight. However, under poor light condition a U or V notch can be hard to see, but the white triangle along with an ivory bead front sight would stand out better than most styles. Even today we use both ivory and silver-color front beads, and we aren't a bit hesitant about installing a Raybar front sight that acts much like a neon light.

When light conditions permitted, it was a simple matter to fold back the bar leaf and lift up the notched leaf. On this sight, the two leaves are for the same elevation, and they fold in opposite directions.

Due to the focusing problems with iron sights discussed earlier, sighting in a rifle equipped with them should be done by the user. Each shooter sees things somewhat differently. With an aperture sight, standard procedure is to just look through — not at — the rear peep and set the bullseye on top of the front sight. Some claim a sliver of white should be visible between the bullseye and the top of the front sight, as this shows exactly where the target is in relation to the sight. Otherwise the sight can edge into the target a variable amount. This seems simple, but a bit of white to one shooter may not be the same as to another. In my early days of operating the sight-in range, I ran into this more than once. I finally found it easier to instruct the shooter to "balance" the bullseye on top of the front sight. The average person could do that better than trying to leave a consistent amount of white between the top of the front sight and the bottom of the bullseye.

The open rear sight presents even more problems. With the aperture, it is just a matter of looking through it; most of the light comes through the center. However, with an open rear sight, the front sight has to be "fitted" somewhere in the notch. Each shooter presented different problems. With some, filling the U or V flush to the top with the front sight was the answer. Other shooters just couldn't get the hang of that method, and they would do better by only partly filing the notch with the front sight. Some insisted on holding dead center in the bullseye, while others, remembering their military experience, put the bullseye on top of the front sight.

After a shooter had done well on the 50-yard range, I would insist that he take several shots at the 100-yard target. Results would rarely be consistent. I won't say groups were always a foot wide, but it was common to have bullet holes all over the target. I am convinced the majority of these hunters simply couldn't see precisely where they were aiming. I want to reiterate that this

wasn't always the case. Every now and then, someone did very well with open sights. But for the most part, the human eye does not seem capable of seeing well enough to shoot small groups at long range with open sights.

Despite the problems with the open sight, that's the kind that normally comes on a new gun. And despite what some manufacturers think, many of these are still in use, so the shooter must know something about zeroing in with them if he is to hit anything. Normally, the rear sight is adjusted to do this. Most have a stepped ramp which can be moved ahead or back to lower or raise the V notch, and thus the bullet's impact. The steps are rather coarse, and often none will give the desired elevation, one giving too high an impact, the adjoining one too low. In such as case, the only recourse is to file the "high" one down a trifle and hope. Also, there's usually no easy way to make a horizontal adjustment except by tapping the entire rear sight left or right in the dovetail which secures it to the barrel. This is a cut and try effort, of course, and often requires the expenditure of enough ammo that it would be just as cheap and a lot easier to buy an adjustable aperture sight or a Williams Guide Sight. This is an open design which can be easily adjusted in both directions. Seeing a rear sight noticeably off center on the barrel always irritated me, too. In some cases I moved both the front and rear sights to avoid having the rear one too far off the centerline.

Many young hunters don't understand how to adjust open sights. The problem stems from the fact that the shooter doesn't know which way to move the rear sight. Well, it's as easy as falling off a log. With metallic sights you always move the rear sight in the direction you want the bullet to move. In other words, if the bullet hits to the left of the aiming point, the rear sight must be moved to the right — the same direction the bullet must move to get into the bullseye. If the rifle is shooting low, the rear sight must be raised to bring the bullet up.

A very tiny adjustment will move the bullet inches at 100 yards. If the rear sight has no windage adjustment, scribe a line on the barrel before moving the sight right or left. This will show how far the sight has been moved. At best, this is a trial and error method, but it will get the job done.

When I had the sight in range, customers often asked if there was a sure-fire method for knowing how far to drive the non-adjustable rear sight. I had to admit it was possible to work it out mathematically. The usual method is to measure the distance between the front and rear sights in inches and divide that figure into the number of inches to the target. At 100 yards, that would be 3600 inches. That gives a radius multiple, which means the movement of the rear sight will be multiplied that many times. For instance, on a rifle I just measured the sight radius is 17¼ inches. Dividing that into 3600 (the number

of inches in 100 yards), gives a radius multiple of 209. Thus if the rear sight is moved 1/32 inch, the bullet will move 209 times 1/32, or 6 1/2 inches.

The front sight is seldom adjusted during a sight-in, but there are times when a slight movement left or right in the dovetail can be helpful. Unlike the rear sight, the front sight is moved in the opposite direction from the way you want the bullet to move. If the rifle is still hitting high after all the adjustment is used in the rear sight, a higher front sight must be installed. And if the bullet is hitting to the right, the front sight must be moved to the left to get zeroed. Fortunately, today's rear sights usually have adequate adjustment, so there is seldom any need to touch the front sight.

Over the years I used the trial and error method, I didn't try to figure mathematically how far to move the rear sight nor did I zero in first at 25 yards. With open sights, I started firing on the 50-yard range, made corrections until I was in the black, and then moved to the 100-yard target. I'm not downgrading other methods; it was just that I preferred to shoot at 50 and 100 yards. There was no need for calculating; the results were plain and clear.

Aperture sights and some modern open sights have adjusting screws, but most older open sights must be moved by force. Any gunsmith will agree that both front and rear sights are often battered unnecessarily. In fact, there is no need to hammer against the sight. Placing a brass drift punch against the side of the rear sight and tapping it lightly moves the sight a little at a time, and a little is all it usually takes. Brass is softer than steel and won't mar or damage the sight.

I use a William Front Sight Pusher when adjusting or replacing a front sight. Hammering the front sight damages it and can loosen the ramp. The simple Williams device puts equal opposing pressures on the sight and ramp, and permits installation or adjustment without marring anything.

The open sight's glory days are over, but some form of it doubtless will continue to be supplied on factory rifles for years to come. It's not my intent to criticize such a sight, but since it has nothing to offer in the way of target definition or for correcting certain common eye problems, somewhere in the future it will eventually become just another interesting piece of Americana.

Scope Basics

ONE OF THE drawbacks in shooting is the rifleman's inability to see the target perfectly. It's not just old or weak eyes that are responsible for this problem; it can be weather, distance or thick vegetation. Even the dullness of a winter morning or the haze of evening adds extra strain on the eye when using metallic sights. The situation is compounded when the hunter's eyes are weak or failing. It's a constant battle, and there are few times in the woods when everything is right for a rifle equipped with open sights.

It is claimed by some that as mankind grows wiser, the body grows weaker. If that is the case, it doesn't mean these detrimental elements connected with open sights are products of the last few decades; these demons have plagued shooters since the first sights were installed on a shoulder arm. I can say that with authority because scopes have been around much longer than most people think.

I can't pinpoint who used the first optical sight, but tradition has it that Sir Isaac Newton (1642-1727) of law of gravity fame and Frederick the Great (1712-1786), King of Prussia, had some association with a type of optical sight. That suggests some long range shooters were tinkering with the optical sight two and one-half or three centuries ago.

As far back as 1200, scientists were experimenting with magnifying lenses. In 1608, Hans Lippershey, a Dutch optician, created the first telescope, followed two years later by the Italian astronomer Galileo, whose scientific work with his telescopes brought him fame which remains to this day. Most such instruments were of low power and small field of view. Galileo's most powerful telescope magnified thirty-three times and its field of view was roughly one-quarter of the moon.

Still, the die was cast. There were problems with these telescopes since the object was seen upside down and reversed left to right. That's no problem

when looking at celestial objects, but it sure would play havoc on a long woodchuck shot. In a riflescope, the erecting lenses reverse the reversed image to form a normal one.

There is disagreement about the early so-called optical or "telescopic" rifle sights. When Newton and Frederick the Great fixed such sights to their firearms, it is pure speculation whether all of them had optics or were just tubes without lenses. With just tubes there would be no magnification of the target, but the shooter's optical acuity would be concentrated in the tube.

It's of little significance if those early sights were prototypes of today's riflescopes or if they were just aiming aids. Concentrating the shooter's vision in a tube and shielding the aiming device from random light changes would enable him to be more precise. It would also prove the shooter of that era realized a good aiming device was needed for long range shooting.

No matter when the true riflescope came along, it was not an overnight success. In fact, there is still a contingent of hunters who stay clear of the scope. I have listened to numerous arguments against scopes, and most of them, to my way of thinking, don't make sense. A common argument is that by using one the hunter is taking unfair advantage over the animal being hunted. There's not much logic in that attitude. If it were valid, how could the same persons recommend using binoculars to search for game on distant hillsides or on mountain crags? The way I see it, someone goes hunting with the basic purpose of killing something. Anything that helps him to do this legally, quickly and efficiently is to be valued. It's far better to use a scope to place a bullet precisely and get an instantaneous kill than to use less efficient sights that might result in a gut-shot animal that will escape to die a lingering and wasteful death.

The truth is, a hunter can't shoot any better than he can see. Most shooters don't do well with open sights because of a vision problem; they can't see the target and sights clearly. This is because the three items involved (the rear sight, front sight and target) are not at the same distance from the eye. The eye is unable to focus at the three distances simultaneously. The eye tires quickly under strain and, when a shooter spends too much time trying to get a sight picture, starts to blur. Most of the time, the hunter fires without being sure of his sight picture. The scope takes the guesswork out of aiming. With a properly mounted scope that is focused for the user's eye, precise bullet placement is possible at hundreds of yards. There is no strain on the eye, and to the hunter the reticle (aiming device in the scope) and the target appear as part of the same image, both in sharp focus for his eye. The proof of the pudding is the great number of one-shot kills today's hunters are making with scoped rifles, many at incredible distances.

This impressive bunch of medium power scopes, mostly 6x42 and 8x56 models from Middle Europe, gives some idea of what's available to big game hunters who specialize in long range shooting.

I recall a hunt in Forest County around 1940. It was the first Saturday in buck season, and warm weather and a fresh snow had brought out hundreds of hunters. The shooting started as soon as the sun began to burn away the morning's haze. I distinctly remember the long strings of shots that day. The first strings were distant rumbles, then came a slight pause, and then another five or six shots filled the morning air. It was obvious a buck was headed in my direction. Several times I heard a single report, and each time thought it was a finishing shot by some lucky hunter. Then the shooting would start again. Each time a single shot cut through the air, I heard myself muttering about my bad luck.

Suddenly the air was filled with close shots, and I half-raised my Enfield 30-06. Straining my eyes in the direction of the shooting, I made out a deer sneaking through the brush a hundred yards distant. It was a buck. The rack was high and white, but I couldn't get a clear sight picture in the heavy vegetation; there just wasn't enough light. Although I was tempted, I know better than to just blast away through the brush. My only alternative was to wait and hope for an open shot. The picture brightened. Ten more feet would put the buck in a clearing and give me the kind of shot I had dreamed about for months. It was just a matter of waiting until he stepped into the clearing. But that never came to pass.

The buck collapsed as a single shot broke the stillness. I looked around, but the woods were bare. Then, quite a distance above me, a hunter broke out of the brush and hurried down the hillside. I wondered how he could have made such a long shot. He passed without seeing me, but I saw the

answer to my question: he had a scope on his rifle. It gave me second thoughts about the full buckhorn that decorated my outfit.

The old cry that "anybody can hit with a scope" was born in the days when most hunters couldn't afford one. There was a bit of envy involved in this complaint. One hunter told me he didn't want any visual help; when his eyes got to the point that he needed a scope, he would quit hunting. I thought that statement was strange as he was wearing glasses. By his own logic he should have quit reading when his eyes got to the point he needed them. Such arguments are ridiculous.

I have no idea how many shots were fired at that buck dropped by a single shot from a scoped rifle, but I would guess several dozen. Is it fair to say all the misses were due to poor shooting, or were some the results of hunters not being able to aim precisely? Most of the string-type firing was at a moving target, but I doubt if every shot was fired at a bounding deer. When I first saw it, it was sneaking. I'm sure I would have hit the walking deer if I could have got a clear sight picture. The hunter with the scope had that advantage, even though he had to shoot twice as far. The scope is not a panacea for all types of shooting problems, and it won't guarantee success, but it does give the hunter a brighter, clearer picture of the target than is possible with any metallic sight.

The aperture sight was a major improvement over the V-type rear sight, yet it never seemed to gain many followers from the hunting ranks. Target shooters took advantage of the fully adjustable aperture sight, but the majority of hunters felt it was too fragile. The open sight not only looked more secure, it was less susceptible to bumps. I know from experience. I once loaned a 22 rimfire to a farmer at butchering time. After he shot the first hog, he placed the rifle against a fence and grabbed his sticking knife. Unfortunately, the peep sight caught on a fence rail and put a real job on it. In fact, it was damaged so badly I threw it away. Worse yet, the old man made no offer to reimburse me, and went so far as to complain about "having a crazy sight that sticks up like a cornstalk stubble."

The military went with aperture sights during World War II, and I have often wondered why returning veterans didn't automatically take to this design when it had so much to offer. But they didn't, and just after that war scopes began replacing open sights in the hunting fraternity. I have never quite figured that out, but how can I when I didn't follow my own thinking. I couldn't wait to get a scope on my Model 43 Winchester Hornet.

It comes down to common sense. Metallic sights, no matter how sophisticated they are, do nothing to enhance the target's image for the hunter. They neither magnify the target nor make it appear brighter. But a

scope does. The scope helps the hunter see the target more clearly. If I'd had a scope on that dull morning in 1940, it's very likely the hunter on the hill would have watched me tag a buck because I had several shooting opportunities before he did, but the buckhorn rear sight blocked my vision. I hate to say this, but with all the accolades once heaped on the famous buckhorn design, it wasn't half the sight it was cracked up to be.

I said earlier that a hunter can't shoot any better than he can see, and that's the truth. With open sights, the target never appears closer, and when the eye has to deal with sights, distance and the target, its resolving power is greatly impaired. Hawks, for instance, can see a mouse a hundred yards below. Now, it's possible some people could see a mouse that far but, unlike the hawk, they would see only a moving object. The hawk sees a mouse. That's resolving power — being able to define exactly what you are looking at. Remember the tiny target square I put on the mailbox post? Neither Helen nor I could see it clearly, yet our 7-year-old granddaughter Jamie told us it was a "red square." That's just how much more resolving power her young eyes had.

In one sense of the word, a scope offers the hunter resolving power far beyond what the naked eye has. Resolving power is more than just identifying the target. The scope aids the hunter by allowing him to separate the target from other similar objects around it. This brings to mind a humorous episode. A hunting pal who was dead set against scopes and binoculars for any type of hunting cut loose two shots across a wide ravine. I was watching from the edge of a hayfield, and when I recognized him through the binoculars, I sauntered over to see how he was making out. I was still a hundred yards from him when he motioned for me to stop. After he let the third shot go, he gave the OK sign for me to continue. When I arrived, he told me he'd been shooting at a chuck. He was puzzled as to how he had missed its head two shots. After staring a little bit, he said even the third shot must have missed as the chuck was still visible.

When I looked across the 150-yard expanse, my 8x binoculars revealed nothing that looked like a chuck. All I could see was a tuft of grass on top of a small pile of dirt. When I informed him of my find, he vehemently denied he had shot at anything but a chuck's head. He wouldn't look through the binoculars but did agree to check out the shots. As I expected, he'd shot at the tuft of grass. It was on a dirt pile above an unused hole that hadn't seen a chuck in several summers. I did have to agree that one shot might have passed through the grass. While we sat there awhile talking, with the aid of my binoculars and scoped varmint rifle, he shot two chucks beyond the 200-yard mark. He left the field a dyed-in-the-wool scoped rifle convert.

When using an open sight, such as the full buckhorn, much of the shooter's vision is blocked. An aperture sight mounted fairly close to the eye eliminates a good bit of this problem. With a scope, the shooter sees not only the target but also a lot of territory around it.

A scope should not be used to examine an unidentified object that "looks like game." That is what binoculars are for. It gives an uneasy feeling to see a hunter looking in your direction with his scope. That is a dangerous practice. There is always a possibility that the rifle could discharge, causing an accident.

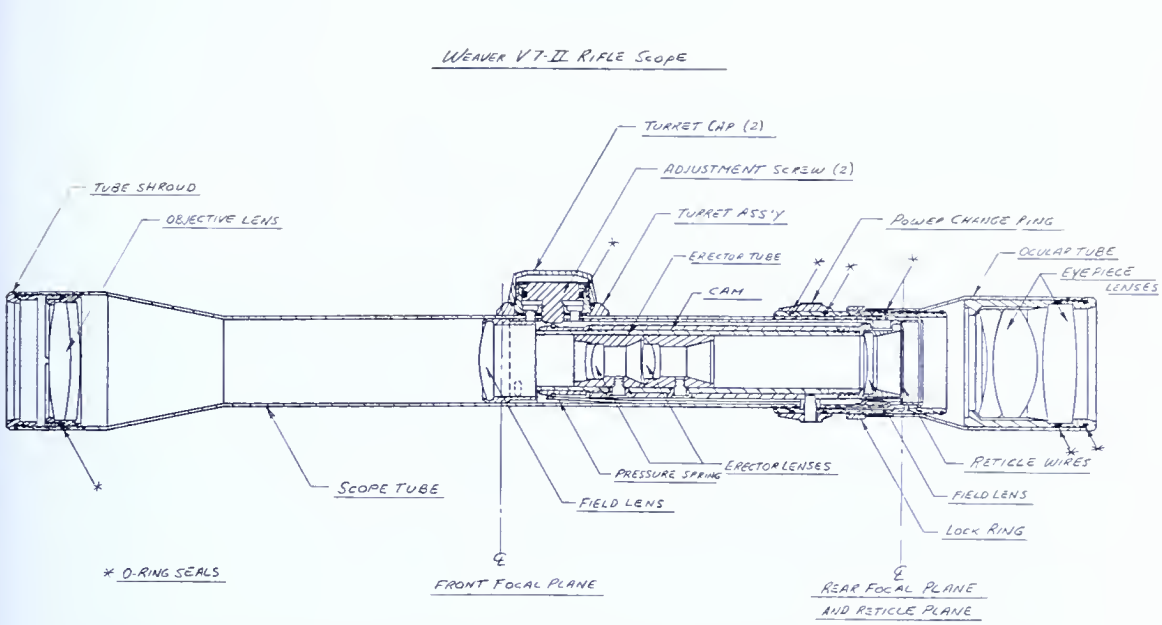
There's nothing wrong with checking out a fully identified animal with a scope to see if it's legal. I once spotted a deer on a hillside several hundred yards away. It was in plain view, but I couldn't be certain it had antlers. Even when it stopped and stood motionless, nothing in the way of a rack was visible. I cranked my 2½-7x scope to full power and saw instantly that it was a legal spike. I dropped it with a rested shot. The 7x magnification helped me, in this situation, in two ways. First, it made identification possible, and second, the fairly high magnification allowed me to place my bullet precisely.

Although the advantages of the riflescope were clear as the nose on your face, early scopes weren't fully dependable and most were difficult to adjust. Basically, the old jobs had screws in the mounts for windage and elevation.

I was surprised to find a telescopic sight advertisement in the 1903 catalog of the A.J. Rummel Arms Co. It shows a Stevens telescopic sight mounted flush with the receiver and barrel of a lever action rifle. The advertising dispels the old myths that scopes were not understood and that no efforts were made to build hunting types. Here's what the old catalog had to say:

"These telescopes are made especially for hunting and target use. The scope for target use need not necessarily have such a large field or broad illuminated vista as the hunting scope, but should have increased power or ability to increase the diameter of the object. The target scopes are made with small field but intense magnifying power or definition, which quality is rated in times multiplied or for short diameters, of the object. The hunting scope should have a large field, suitable for covering the game when in motion, and therefore cannot have such high magnifying power or increased diameters." It goes on to say that mountings on Winchester, Marlin and Savage rifles have screw adjustments for both elevation and windage.

Fixed power ranges on those old Stevens scopes ran from 4x to 12x. Tube diameter measured ¾ inch. The rifle had to be sent to the factory for mounting and sighting in. Both top and side mountings were offered. Prices ran from $8 to $19 for scope and mount, with $1 extra for a side mount that allowed the use of the regular sights.



Cutaway illustration of Weaver V7 shows that typical hunting scope is not simple. Dimensions and locations of all lenses and mechanical units must be extremely precise, and these relationships must be maintained even under heavy recoil.

Scope sights were involved in competitive shooting at least as far back as 1870, but the real motivating factor in their development came during World War I. I'm not overlooking the fact that snipers on both sides used telescopic sights during the Civil War, but I don't think the numbers were nearly as significant as in WWI. The Germans in particular, with their fine optical companies, used such trained riflemen effectively.

During the post-WWI years, both rifles and ammunition were refined. It can be said that the rifle had more accuracy potential than the shooter could fully utilize with open sights. Hence, the need for a better aiming device. However, the best scopes available then were imported and expensive. In Europe, the hunter, usually a well-to-do person, did most of his shooting from a high stand during the early morning or late evening hours. These hunters found a scope's magnifying power and light gathering ability made clean kills possible when the game couldn't be seen through metallic sights. The hunting scope was more popular in Europe at that time than in America. But things would soon change.

European scopes such as Hensoldt, Zeiss and Kahles were occasionally mentioned in the *American Rifleman* during the 1920s and early '30s, but few hunters could afford the imported scope. In 1932, a Zeiss 4x Zielvier sold for $45. During that same time period, a new Model 54 Winchester rifle cost $45. By the time a mount was bought for $20 and the installation was paid for, getting a scope cost almost twice as much as the rifle.

At this very point in history, a Kentucky-born, self-made optical expert stepped into the picture. His name was Bill Weaver, and he changed the shooting world forever. Weaver had experimented with European scopes but didn't think most were practical for our hunting situations, so began to build his own. The first model he sold was the 3-30 (named for its power, 3x, and

the year, 1930). Its price was $19, which put it in the realm of possibility for many hunters who could only dream of a Zeiss, though even $19 was a lot of money in those Depression days. Weaver's 3-30 evolved into the legendary Model 330, the first widely popular American-made big game scope. When, a short time later, doctors advised Bill Weaver to seek a drier climate, he packed up and moved to El Paso, Texas, and started what became the biggest scope manufacturing plant in the world.

Not only had Weaver designed a scope which would hold a unique place in hunting history, but he also designed all the tooling and fixtures to produce it. From the powerful equipment that shaped the steel tubes to delicate instruments that would grind and polish glass lenses, everything was under one roof. It's interesting to note that the Model 330, Weaver's first high volume model, was also used on the M1903A4 Springfield rifle by American snipers in World War II. It was then called the M-73B1.

I doubt if anyone back then realized it, but that was the beginning of a new era for the American hunter. The rifle scope was here to stay, and would eventually become an integral part of the shooting scene. The surge in the scope's popularity was hardly due to just the relatively low price of the Weaver 330. I'm sure that was an important factor with many hunters, but so was the Weaver Company's continuous advancement in quality which allowed shooters to obtain greater accuracy and dependability than ever before.

I have always been a strong advocate of accuracy. I'm not sold on firepower alone in the hunting realm. I'm not opposed to metallic sights, but nothing short of a scope offers precise bullet placement at long ranges. And proper bullet placement means cleaner, quicker kills, and that's what accuracy is all about.

What makes a scope superior to even the best open sight? There's more than one answer, but magnification leads the list. Go back to the buck on the hillside. If I hadn't had a scope, it would have remained a deer of unknown sex. With the 7x scope, I could tell it was a legal deer and, on top of that, I could make a satisfying shot.

I have spent at least five decades matching my 22 rifle shooting skills with old *Sciurus carolinensis,* the common gray squirrel, so I know a little bit about shooting in poor light conditions. In my early days, opens sights were standard on every rifle, and I have been as frustrated as anyone in trying to aim at a squirrel high in the crown of a leafy oak. In the morning, it was haze, in the evening, the ever-engulfing shadows. No matter how you cut it, open sights were practically useless under those conditions.

The scope doesn't wipe away the haze, nor does it push back the shadows.

But it does gather more light. It also makes the target appear larger or closer, which permits the eye to make out more detail. What would be a blur with open sights, now turns out to be a well-defined target. With a scope's bright field of view and single aiming device, the hunter is well prepared for all types of light conditions.

If magnification leads the list of why a scope is superior to open sights, the single aiming device (reticle) has to come in second. In fact, after using hundreds of scopes on the range and in the field, I believe the reticle's input is every bit as important as the scope's magnifying ability. The scope, when properly adjusted for the shooter, becomes an extension of his own optical system. The target and aiming point are always in focus with the shooting eye. The reticle appears implanted on the target, and the shooter can select the aiming point. Furthermore, the scope's field of view permits the shooter to see as much below the reticle as above it. All of these factors are lacking with open sights. Just being able to see clearly justifies the scope sight for hunting.

Correcting some types of eyesight problems is another benefit offered by the scope. Perhaps the most common problems are nearsightedness and farsightedness. These conditions, which plague most shooters over forty, can be eliminated by adjusting the ocular lens (eyepiece). When this is done correctly, the target's image will be sharp and clear at all shooting distances. So here again, I have to question whether magnification is a scope's most important quality.

I once happened to see a hunter in Jefferson County aim his rifle in several different directions. He repeatedly aimed low and high, and then finally lowered the rifle. I couldn't see what he was looking at, and couldn't figure out why he didn't shoot. After watching for more than a minute, it was obvious he was having some type of scope problem.

"Know anything about scopes?" he asked as I approached.

"A little," I answered. "What seems to be the problem?"

"My scope is fogged. I can barely make out the crosswire."

"Did you drop the rifle, or when did you first notice it?"

"It's been that way all morning. Here, take a look, and see what you think."

One glance showed me the problem. The eyepiece was almost ready to fall off. I turned it in until it the reticle was sharp and clear and handed it to the hunter. I won't repeat the comments he made about the fellow who installed and adjusted the scope, but the snow seem to melt slightly for thirty feet around us.

Focusing the eyepiece for the person who will use the scope is mandatory.

We are talking here about making adjustments so the aiming point — the reticle — is in precise focus for the user's eye, not about focusing the scope for the exact distance to the target; that is done by screwing the objective lens in or out, as on a target or varmint scope. Usually, scopes come from the maker with the eyepiece adjusted for normal vision. If that is the case with your new one, and your eyes are normal, you'll be able to see the reticle sharp and clear the instant you look through it. But if there is any sort of fuzziness or dullness, or perhaps a ghost image paralleling the reticle, the eyepiece needs adjusting for your individual aiming eye. No one else can do this for you. It is best done by pointing the scope at a dull cloudless sky and looking into it for a couple of seconds. Don't look too long or your eye will adjust to some extent to overcome any minor imperfection in focus. If the reticle is not instantly clear and sharp, screw the eyepiece out five or six turns and take another glance. If it's getting better, fine tune it till it's sharp. If it gets worse, go the other way half a dozen turns past the original setting and work it out. Once properly adjusted for your eyes, it won't have to be moved again until there is a change in your eyesight, so take the time to get it right in the beginning. You'll then be getting the optical efficiency you paid for.

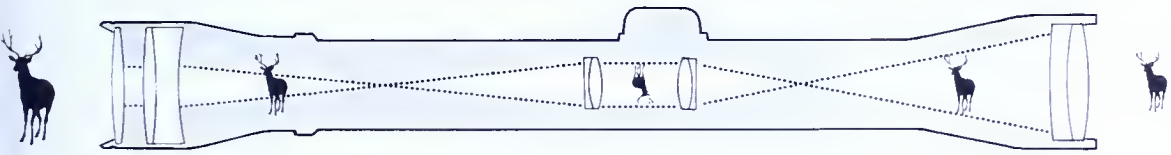
I have had the argument tossed at me many times that iron sights are much faster to use than scopes. This is as false as a seven dollar bill. When a scope is positioned properly for the hunter's natural shooting stance, and correctly focused, the scope is fully as fast, and perhaps even faster, than open sights, and that includes the famous buckhorn or some highly touted aperture sights. Why is that? It's simple. First, there is a sharp picture of the game the instant the hunter shoulders the rifle. This factor alone is an advantage over any metallic sight. Secondly, with the reticle in the same sharp focal plane as the game, no time is wasted alternately focusing the eye at two or three distances.

Many hunters are afraid they won't be able to see through the scope when game appears. This stems mainly from improperly mounted scopes and the lack of practice. There can be a transition period when switching to a scope. If a hunter has spent many years using metallic sights, he has to learn to use a scope. It is a somewhat different ball game.

Most of the problems encountered are due to poor scope positioning when mounted, but this will be explained later. From what I observed over decades of mounting scopes, it's unlikely any hunter who has learned the proper way of using one will go back to the iron sights. It's important that a scope be mounted long before the hunting season, so the hunter can spend considerable time "dry firing" the rifle. I normally suggested that after making certain the rifle was unloaded, the shooter spend some time each day

tossing it quickly to his shoulder. At first, perhaps nothing will be seen, but in short order the field of view will appear the moment the buttplate hits the shoulder. This indicates the eye is the correct distance from the eyepiece. When this becomes routine, pick out a specific object in the field of view. Find a rock 60 to 75 yards away, then flip the gun up, find it in the scope, and get the reticle on it. Do this regularly for some weeks before the season and it will eliminate any problem of seeing through the scope the instant the face touches the comb.

At this point, let's get into the general makeup of the riflescope. I'm not an optical expert, so I won't try to get technical, but the design of most scopes is essentially the same. Every riflescope, including those for target and hunting, consists of a tube (almost always steel or hardened aluminum) which holds the lenses and mechanical units in the proper relationships to each other. At the front end of the tube is a lens which gathers light rays reflected from every object within the scope's field of view (thus this is called an "objective" lens) and assembles them into an image within the tube. The distance from the lens at which this image is formed depends largely upon the curvature of the lens surface and is called the focal length of that lens. It is a characteristic of such lenses that they create an image which is upside down and reversed left to right. As the light rays continue, they pass through a set of erector lenses which invert the reversed image and create a normal one farther along in the tube. From there the light rays pass on through the ocular lens and into the pupil of the shooter's eye. In actuality, an objective is almost never a single lens, but is usually a combination of two or possibly three, as are the erectors and the ocular; however, they are commonly referred to in the singular. There are also several other "field" lenses in the system which collect and alter the paths of the light rays.



Schematic drawing of Weaver scope shows how objective lens (right) turns target image upside down (and left to right); erector lenses, center, then invert the reversed image to present it to the eye in normal position.

It should be noted that there are only two places within the tube where an actual image of the field of view is reproduced — at the focal planes of the objective and erector lenses. This is important because it means these are the only places within the tube that the reticle can be positioned. If it were put

anywhere else, it would be invisible — and useless. There can be reasons for an optical designer to prefer one focal plane over the other, but in a basic sense the reticle can go in either plane.

The reticle of course is essential to a riflescope for it is the device which permits aiming at a target. However, it does not automatically align itself with the bullet's path, so there has to be a system by which the shooter can do this. Thus a scope has windage and elevation adjustments which, to avoid a haphazard shoot-and-twist approach, are calibrated in minutes of angle or fractions thereof. In almost all of today's scopes, the erector lenses are contained within a tube inside the main one. It is attached to a pivot at one end, while the other is held by spring pressure against the windage and elevation adjustment screws. When adjustments are made, they shove the inner tube in one direction or another so that the shooter can get the reticle into the optimum relationship with the bullet's point of impact. When zeroing in, you don't change the bullet's path to match the line of sight; you adjust the reticle to match the bullet's path — or actually to get as close to it as practicable. Since the line of sight is straight and the bullet's path is always a curve, there are only two places at which they can be made to intersect.

Right at this point, I can explain why a scope is superior to open sights. The four basic elements just named, plus the human eye, make up an optical system that will give the shooter a sharp, bright image of the target and the reticle. Not one of these elements is more important that the others. Each is indispensable. Each has a specific function, and to get the desired results the entire system must be balanced.

It's obvious that the desired result from a scope is an enlarged, sharp, distortion-free image. In scope vernacular, the ability of the scope to make out detail is called resolving power or definition. It's also obvious, since the scope is a sophisticated piece of optical equipment, that the sharpness and clearness of the image is dependent upon the quality and optical excellence of the scope. You might say that the reputation of the scope's manufacturer depends upon the quality of the image seen. How well the hunter can shoot is largely determined by how clearly he sees the target.

You might wonder why some scopes offer high quality definition, and others do not. Well, optical excellence is not a product of good fortune or sheer luck; it's the use of good materials, the manufacturer's attention to the best optical design, precision assembly, and the correction of certain optical deficiencies. This requires skill and top quality materials, both of which push up production costs. Thus the higher prices of some scopes are not to be construed as just higher profits. Quality scopes cost more to manufacture, and you can write that in stone.

One reason today's scopes offer a sharper brighter image is lens coating. Optical designers had known for generations that all of the light which struck a lens did not pass through that lens. At each air-glass surface, some was reflected away. Thus in a unit such as a scope, which might have a dozen lenses, a high percentage of the light which entered the scope did not reach the shooter's eye; some did not even enter the front surface of the objective lens. Lens coating changed that significantly. Some optical experts claim that lens coating is the most important development in optical history. The Germans — actually Carl Zeiss, Inc. — developed it first, in the mid-1930s. Due to the military buildup at that time, the German government kept it to themselves.

Why is lens coating so important? It increases light transmission by reducing losses due to reflections from air-to-glass surfaces by as much as 65 to 90 percent. According to Bausch & Lomb, the variation depends upon the type of glass to which it is applied, the angle of the light approaching the surface, and the thickness of the coating as related to the wavelength of light being reflected.

Lenses are coated by a molecular bombardment of magnesium fluoride, one-quarter wavelength (some six millionths of an inch) thick, on a glass surface of optical cleanliness. Bausch & Lomb says "the work is done under extreme high vacuum, and is a process of highest technical nicety." A greater amount of the light that enters the objective lens now gets to the eye. In a scope with uncoated lenses, some of the light rays are bounced back and forth inside the tube. This creates a dullness of the image. When these reflections or flares are reduced, more light gets to the eye, giving an improved image.

You can easily see what I'm driving at by looking in a window from outside your house. You not only see into the house, but you also see an image of yourself in the window. This happens because all the light rays did not pass through the window glass. Lens coating puts more light in the shooter's eye.

Lens coating is visible as a color, usually blue to purple, on the external lens surfaces of a scope. The precise color doesn't mean a thing. Bausch & Lomb says, "This color is not due to any color in the coating material itself, which is colorless. The waves of energy which we know as light range in length from about .000016-inch to .000028-inch, the different colors of light being waves of various lengths. Since the maximum effectiveness of antireflection coating depends on it being a quarter-wave thick, it follows that maximum reflection-elimination will be affected for light of one particular wave length or color. Waves of other lengths will have greater

A small variable such as this 1.7-5x Leupold provides a very large field at bottom power for woods use on fast moving game, adequate magnification at top end for the longer shots when necessary.

relative reflection. The color of the coating is the somewhat greater reflection of the complementary color to that for which the coating is of maximum effectiveness."

Lens coating is a technical and complex procedure. It works to maximum efficiency only when every air-to-glass surface in the scope is coated properly. On some inexpensive scopes, coating is applied to only one surface of each of the two outside lenses. That is not the way it should be done. Also, not all lens coating is of equal durability. When cleaning the two outside lens surfaces of a scope, blow or gently brush off the particles of dirt or dust. After the heavy particles are removed, clean the lens with a regular lens cleaning cloth or a facial tissue.

Lenses in today's riflescopes are precision ground. In fact, one scopemaker told me that even inexpensive scopes usually have high quality lenses. He claimed the heart of a scope was in its construction. Every lens, be it in a camera, binocular or scope, has certain optical deficiencies known as aberrations. To obtain optical excellence means correcting these deficiencies. The more skillfully and thoroughly aberrations are dealt with, the better the instrument.

Some years ago, I purchased a used photo enlarger. It was a well known brand, but it wasn't equipped with the manufacturer's lenses. The previous owner had assured me it printed high quality enlargements but, right from the start, I could detect a dullness. Prints looked good but not great; something was missing. White areas weren't white and black areas weren't black. Yet the same negatives would produce sharp, clear photos in my son-in-law's enlarger. The difference wasn't much, but it was there just the same. When I purchased a high quality lens, the problem was solved. Nothing

could be seen when looking at the enlarger's lenses, but some optical aberration hadn't been corrected.

With a scope, or any other optical instrument, the entire system must be treated as a unit. An aberration in the first lens must be overcome, so far as possible, by the shape and composition of the following lens. That lens of course introduces aberrations of its own, and these are dealt with in subsequent lenses. The end result — the image presented to the eye — is never a perfect reproduction of the original "target," but it is of extremely high quality from today's best scopes.

The diameter of the objective lens plays an important role in a scope's resolving power. Bausch & Lomb has this to say about the diameter of the objective lens in relation to resolving power: "For low-power telescopes . . such as used in rifle sights, the limiting factor of resolution is the human eye. Optical design is based on the fact that the finest detail which can be resolved by the normal eye subtends 1 minute — or 60 seconds — of arc. A good 20mm objective lens will resolve 5.6 seconds. This means that a scope with such an objective would have to have an eyepiece producing something more than 10x magnification (5.6 x 10 = 56) before its limit in resolving power would be seen by the human eye. At any power less than 10x, the resolving power of such a 20mm objective is greater than the ability of the eye to see it."

Maybe I have the cart ahead of the horse. Let's go back and take a quick look at the various aberrations which, if not corrected, will degrade a scope's performance. This information is taken largely from Bausch & Lomb's "Facts About Telescopic Sights," a highly informative publication. There are six aberrations important to shooters: spherical, chromatic, distortion, coma, curvature, and astigmatism. The first two are the most serious. Both result from the fact that the lenses used in scopes must have curved surfaces to alter the paths of the light rays passing through; this also means that the different areas of a lens have different thicknesses, and this in turn means that different parts of the image created by the lens fall at slightly different distances from that lens. That is, the focal plane of such a lens is not a perfectly flat surface. Therefore, the entire image is not in sharp focus, so there is an inevitable falling off in definition. This condition is known as spherical aberration.

Chromatic (color) aberration occurs because any single lens is unable to bring to a common focus the various colors — infrared to ultraviolet — that make up the visible light spectrum. The result is a color halo around each detail of the image, which creates a sort of blurring effect. Chromatic aberration is corrected by using different kinds of glass for adjacent lenses;

usually crown and flint glasses, of which there are many to choose from, are used. They have different refractive indices, so if properly designed and manufactured can eliminate most of this aberration. Such a corrected lens system is called "achromatic."

Distortion is a term used to describe an image whose shape does not match reality. It occurs when magnification is not the same over the entire field of view, and is usually most apparent at the outer edges of the field. As an example, if a square target frame appears to have rounded corners, magnification is greater at the middle than at the perimeter of the lens; or if the corners are elongated, power is higher at the perimeter than in the middle. It a lens system is corrected to eliminate distortion, it is said to be "orthoscopic." This five dollar word means the magnification is the same over the entire field of view.

Curvature of field happens when the image formed by the lens does not lie on a flat plane. Some shooters check for this by looking at the side of a building. If curvature is present, the wall will not look flat, but bowl-shaped. Unless the entire viewed area is in sharp focus, the scope does not have a flat field. Here, the erector lens system must be properly designed to achieve the desired flatness.

Coma is the term for a spherical aberration that comes about when light passes obliquely through a lens so that a distant point appears as a comet-shape; that is, instead of getting a sharp clean image, each point has a sort of tail. The overall effect is one of blurring because each detail appears slightly smeared.

Astigmatism is the last of the six aberrations. It refers to the inability of a lens to focus at the same time lines lying at different angles. When asigmatism is present, lines going in one direction may appear sharp, while lines at a different angle will be out of focus.

Coming right down to brass tacks, the excellence of a scope's optical system, which is definition of the target, depends upon the maker's ability to produce an optical instrument suited for an intended purpose.

By this time I'm sure most readers have some idea of the complexities of scope making. I think it's safe to say, "all that is bright is not right." Taking a ten second look through a scope will not prove anything. Practically any scope on the market today is vastly superior to those of Bill Weaver's early days. Many of the problems that plagued early scopes, such as fogging or dullness of image, have been eliminated in all of today's models from reputable manufacturers.

Before discussing types of scopes, some thoughts on nomenclature seem appropriate. The main body of a scope is called a tube. It is normally made

of hardened aluminum or steel. It is the house that holds most of a scope's optical system. The diameter of the main tube on most hunting scopes intended for the American market is one inch. Rimfire scopes are usually built on either 3/4- or 7/8-inch tubes. European scope tubes are measured in millimeters, and common diameters run from 26mm to 30mm. Most big game scopes have enlarged eyepieces, and in practically all models above 3x the front end of the tube is also enlarged to accommodate a large lens.

A phone caller who had just purchased a Swarovski 6x42mm wanted to know if he had got some offbeat brand as his Buehler mount rings wouldn't fit the scope's tube. He relaxed somewhat when I told him the Swarovski was a fine scope but instead of having an inch tube it had a 26mm. That's only slightly larger than an inch (which equals 25.4 millimeters) but one-inch rings won't work with it.

Starting at the front, the first lens of a scope is called the objective. Often it is considerably enlarged, especially in high magnification scopes. In some hunting models, such as the Leupold 2.5x Compact, Bausch & Lomb 1.5-6x, Schmidt & Bender 1 1/4-4x, and the Burris 2 3/4 x Long Eye Relief, the objective lens unit is not enlarged. It can be seen that all of these scopes are low in power.

The lens at the tail end of a scope is called the ocular, or eyepiece. There doesn't seem to be any standard measurement for this, nor is the ocular lens always round. Some oculars are essentially rectangular, such as on Redfield's Widefield. This is done to get a bigger field in the horizontal dimension. The rectangular ocular is a touchy subject, and I don't want to get caught in the middle. Personally, I can use it or leave it alone. Helen claims there's nothing

Bob Wise likes 6-24x Bausch & Lomb for his varmint weight M700 Remington 22-250 as it lets him adapt instantly to variations in range and light conditions.

like a wide angle eyepiece. In fact, I had to install a Redfield 2½-7x Widefield on her LSA 25-06.

I really can't argue with her too much, as I use a 2½-7x Low Profile Redfield Widefield on my Ruger RSI M-77 308 deer rifle. By the way, Low Profile means the objective lens is also rectangular in shape. With both objective and ocular lenses "squared," a scope can be mounted very low.

The reticle is a scope's aiming point. It can be any of a multitude of designs, including crosshairs, post, dot, multiple dots, or the plex (some call it duplex) reticle. For the moment, I'll refrain from going any further with reticles as they will be covered comprehensively in discussing how to select a scope.

Magnification is a much-discussed term in the scope realm, but from my point of view it is badly overworked. In fact, after using hundreds of scopes of all powers, I have reached a firm conclusion that most hunters put too much emphasis on the power factor. Since this is an extensive subject, I will discuss it at length in the upcoming chapter.

Relative brightness, sometimes called luminosity, is an optical term that used to scare the pants off shooters. When I operated my gunshop, I often had prospective scope buyers point out that such and such a model didn't have as high a relative brightness figure as another brand. They wanted all the relative brightness they could get but, confidentially, most of them didn't have the slightest idea what the term meant. The unfortunate part of the relative brightness rating is that the buyer might relate a high index figure with scope quality, and no such relationship necessarily exists.

Relative brightness is a numerical rating based on the area of a scope's exit pupil. The exit pupil is the bundle of light rays that comes out the rear end of a scope — the bright disc visible in the eyepiece when the scope is pointed toward a light source. The exit pupil's diameter can be determined by dividing the unobstructed diameter of the objective lens, in millimeters, by the scope's magnification. Squaring that number gives the relative brightness figure. Thus, using a 6x scope with a 30mm objective lens, we divide the power into the objective diameter — 6 into 30 — and get an exit pupil of 5mm. Squaring the 5 gives the scope a relative brightness of 25. If that scope had been a 10x, it would have had an exit pupil of 3mm and a relative brightness of 9. Or if the magnification were 3x, the exit pupil would measure 10mm and the RB would be 100. However, in a practical sense the brightness of the 3x scope would not be four times as great as that of the 10x, as it might seem to be, because that 10mm exit pupil is too large to enter the eye's entrance pupil, which rarely exceeds 5mm in diameter. Thus the difference between 5mm and 10mm is wasted insofar as usable light is concerned.

And then there is parallax, a term that has intrigued and confounded scope users for as long as I can remember. I'm not sure, but I think the parallax problem began a couple of generations ago when some gunwriter stumbled across the word and wrote about it in vague terms so he could convince the readers of his expertise by confusing them. It really isn't that difficult a subject.

Parallax in a scope can be defined as apparent movement in the interrelationship of the reticle and the visual image when the aiming eye is moved at any angle while the scope is motionless. It occurs because the reticle is not positioned exactly in either focal plane. It could be so located if all shooting were done at the same range. Then it would be just a matter of focusing the scope for that distance and installing the reticle where the image was formed. But in hunting, one shot can be at 50 yards, the next at 500. It's a completely random thing, and such variations move the target image a trifle forward or backward within the tube. Since the reticle's position is fixed, the image is formed slightly ahead of or behind it. If the aiming eye is then moved slightly, the different distances to the reticle and the image create a tiny angle which seems to make the reticle move. Since a scope can be in perfect focus for only one range at any given time there is always some parallax at every other range. However, this is usually such a tiny amount that it has little significance in regard to accuracy, tending to be absorbed in other errors over which the shooter has little control.

Actually, parallax does not exist if the aiming eye is always precisely aligned with the optical axis of the scope, for then that little angle simply isn't created. The problem is most likely to occur when the rifle is thrown to the shoulder and fired rapidly. In that case aim might be taken near the perimeter of the exit pupil, which would give maximum parallax. But even here we are talking in terms of only an inch or two of bullet displacement on the target, and this is easily absorbed by the animal's size.

Parallax can be completely eliminated by focusing the scope precisely for any given range. This is not possible with low power big game scopes, as they have no such mechanical adjustment, but it is rarely needed at their magnification level. For high power target and varmint scopes, where the utmost in accuracy is required and a large number of shots might be fired at the same distance, the objective units can usually be screwed in or out to place the image exactly on the reticle.

This chapter has been intended to give some background information on scopes. However, I know from the many letters I've received over the years that when it comes to scopes, most hunters have one basic question: Which one is best for my needs? That's what I intend to discuss next.

Selecting a Scope

"WHAT IS THE best scope on the market?" This simple question ranks as my number one inquiry about scopes. It isn't an ominous-sounding question, nor is it an unexpected one. Yet, no matter how simple this question appears, there is no answer. It comes under the same classification as asking what the world's best car is, where in the U.S.A. is the best place to live, or if it's true that blondes have more fun. It's claimed that only an expert or a fool will attempt to work on the internal parts of a scope. Taking this a bit further, any person attempting to give a definitive answer to "what is the best scope" automatically proves he isn't an expert.

Years ago, when the market had some imported scopes of questionable quality, it was possible to give some observations without skating on thin ice. There were differences in scopes that couldn't be overlooked. As an example, in the late 1950s, I took advantage of a scope deal on an off-brand imported 4x that sounded too good to be true. Later, I learned it was. I placed a minimum order without reading all the small print. When the scopes arrived, there wasn't anything in particular that I could see that would spell trouble. I mounted one on a 300 Magnum and fired it a dozen shots. This crude test was far from conclusive, but no lenses cracked and the reticle was still in place. Everything appeared fine. The metering wheels had a healthy click, and the image was bright and clear. From all appearances, I would be selling a lot of these scopes.

I sold three the first evening. The price was well down the ladder from that of a Weaver or Redfield. Several more went the next day. Business was good, and profits higher than with other brands of scopes. In less than a week, I was getting ready to write an order for 50, which would drop my cost even more, when the roof fell in. It started with a phone call from one of the new owners. He couldn't put the adjustment turret cap back on the scope because

an aluminum spring had come up past the elevation wheel. I couldn't believe my ears. I told him to return the scope as soon as possible, as there had to be something wrong. Believe me, there was.

I had never seen anything like it. It wasn't an aluminum spring that came out; it was a super-thin sliver of aluminum that wound up past the wheel. The owner claimed his rifle shot high, and when he turned the wheel down, the "spring" began to wind out. I got into the act by giving the elevation dial another full turn just to see the stuff spiral out. The surprising part was that the wheel was not difficult to turn.

Since it was deer season, I loaned him another one of the 4x's until I could get his repaired. At least, that's what I thought I was doing. A closer look at the fine print made it clear that I hadn't loaned him a scope, I had given him one. The last few lines of very small print on the bottom of the invoice said the scopes could have minor defects, and that the sale was final and without recourse. I still had three scopes that I would be unable to move without almost literally giving them away. My fears came to fruition; that's exactly what I did.

Over a period of ten days I replaced two more scopes that failed. They didn't all fail due to the same problem. I recall one scope's reticle vanishing like smoke in a windstorm, and another wouldn't meter properly. It was something of a financial disaster, from my point of view. Yet, there is a bit of mystery and satisfaction in this: the scopes I gave out as replacements apparently performed well for their owners, as no one complained a second time. My main concern was with an old fellow who needed a scope but couldn't afford a higher priced outfit. I sold him one at cost for his Model 99 Savage 300. Since literally every one of the first batch I sold had failed, I felt it would be just a matter of time until I heard from him. Yet he never mentioned any problems with his. I came to the conclusion that if he'd had a problem, he might have been embarrassed to mention it because of the low price. Several seasons later, he called to tell me he had dropped a nice doe with the 300 Savage, and he wouldn't have been able to do it without the fine scope I had sold him. Such is life.

The quality built into today's scopes assures the hunter or target shooter of years of service. I won't say that all scopes in today's marketplace are equal. There are still dramatic differences in quality and construction. But for the most part, I think the day of the "junk" scope, like those I just discussed, is over. Most of the inexpensive brands I have tested lately were sharp and clear. Metering was crisp and reasonably precise, and most had flat fields of view without annoying distortion. Hunting-type tests I subjected these scopes to were passed with flying colors. Yet I harbored

doubts about how long they would stand up to the rigors of hunting. Although top quality optics are always desirable, it's the mechanical construction of a scope that determines its lifespan.

The paramount reason for the riflescope's failure to win the hearts of the hunting fraternity after the Great Depression is directly related to an internal condition known as fogging. This term is self-explanatory. When moist air fills the scope, certain atmospheric conditions form minute drops of water in the scope. The scope is literally useless. Back in that time period, a hunter carrying a scoped rifle was fearful of even the slightest weather change. One would have expected every scope manufacturer to make an all-out effort to eradicate this problem, but it wasn't until late in the 1960s that most scope makers could honestly advertise "fog-free" products. Today, it's rare to see a fogged scope, and the reason has little if anything to do with the scope being "nitrogen filled."

It is true that during the transition from the scope that fogged to the scope that didn't, some lower priced imports made quite a stir over being nitrogen filled. This was misleading, and was responsible for thousands of hunters believing that it was the nitrogen itself that kept a scope from fogging. A late acquaintance of mine, who qualified in every respect as being an extremely opinionated bore, took me to task on this very subject. He once proudly shoved a scope under my nose, and said, "Read those words of truth engraved in white if you want to know why I picked this scope." In bold white letters on the eyepiece were the words, "nitrogen filled."

"What's so startling about that," I asked. "Why are you so taken with the fact the scope is filled with nitrogen?"

This M511 Remington Scoremaster carrying a B5 Winchester scope was my first gift to Helen. I can't even guess how many shots we've fired through it, or how many chucks and squirrels it's accounted for. It's one of the outfits we'd never part with.

"She'll never fog," he said in a hoarse whisper. "Come what may, I'm safe as a squirrel in your sights."

This insult didn't pass unnoticed, even though it was a reference to a squirrel I had missed at 50 steps on a bitter winter morning hunting with this fellow. I put up with him, but he had an obnoxious manner that made many people avoid him. The names of his friends, including their addresses, could have been written on the back of a postage stamp.

"You're not any safer with nitrogen than you would be with any type of inert gas or dry air," I fired back.

"Nitrogen will not fog, or weren't you aware of that? With nitrogen in the scope, there's no danger. But perhaps no other gunwriter has informed you of that."

That snide remark didn't go unnoticed, either.

"You're only halfway home with that answer," I cut in. "It's not just having nitrogen in a scope that makes it fogproof, it's keeping it in there that counts. And it has to be dry to begin with. Nitrogen itself is nothing more than a gaseous element. It's the seals that contain the nitrogen that keep a scope fog-free. If the seals leak, the nitrogen escapes and is replaced with air, and air usually has some moisture in it. Then you're back at square one. When there is a drop in temperature the possibility of fogging increases because moisture trapped inside the scope can condense on the inside lens surfaces when the tube chills."

Fogging is a definite indication of leaky construction. For a scope to be fogproof, it must also be waterproof. I realize that few riflescopes are completely waterproof when subjected to pressure — like being submerged several hundred feet. But today's high quality scope is waterproof for all practical field applications. Rain can hammer against it and snow can cover it, but there is little danger of water getting inside.

A simple test will show if a scope has imperfect seals. Submerge the scope several inches deep in a pan of 130-degree water, and make sure the scope is lying flat. The warm water will quickly expand the air inside the scope, and that will create an outward pressure. If any seals are leaking, tiny bubbles will rise. Remove the scope before the water cools. If this isn't done, the lowered temperature will reduce the pressure inside the scope and water will be drawn into the tube. I might also caution that this test should be performed only on scopes that claim to be fogproof.

Conversely, in severe cold weather the air inside a scope tends to shrink, and it will pull in air if there is even a tiny bit of leakage. If the scope fills with moist warm air, there is a serious danger of fogging in late afternoon or evening when temperatures begin to cool.

While you may find this a bit difficult to believe, turning the eyepiece (ocular lens) in or out changes the volume inside the scope a trifle and thus affects its internal pressure.

Some manufacturers of high quality scopes claim there is no need for nitrogen if the scope is assembled in a room where the humidity is carefully controlled and atmospheric dust is filtered out. When scopes are assembled and sealed under normal atmospheres, which could have high moisture content, dry nitrogen or some other inert gas is usually installed.

Although the fogging problem is not as serious as it once was, I still think a scope should not be subjected to conditions that might cause it to fog. For instance, a scope that has soaked up heat all night in a hot camp will be placed under a great deal of stress if the morning temperature is below 15 degrees Fahrenheit. When there is a 50-degree or more instant temperature change, the metal tube contracts. This can affect the seals. If made of poor quality material they will eventually fail, and a fogged scope will be the result. Keeping a big game rifle in the coldest spot in a camp, or perhaps locked in the trunk of a car, could prevent this problem.

Before we get into selecting the right scope for our needs, let's review several things a scope offers. First, it gives the shooter a magnified image of the target which helps him to shoot more accurately. With a single aiming point, the reticle, there is no need to align several parts of a sighting arrangement; the hunter simply places the reticle on the exact spot he wants his bullet to hit. Yet, as elementary as this sounds, not every scope is suitable for every type of hunting. All aspects of a scope must be taken into consideration. An incident that happened to a friend of mine, who had the wrong type of reticle, is a shining example.

This varmint hunting pal was obsessed with high power, thin crosshairs and tiny dots. He believed the reticle couldn't be too thin, the dot too small, or the magnification too high. His successes in the varmint pastures had proven this conclusively, so far as he was concerned. He learned the error of his thinking on a dark, dreary morning in deer season. A buck bounded across a powerline right of way, some 200 yards from my friend, and stopped in patch of scrub oak. The shot would be as easy as taking candy from a baby, or so he thought. When he rested his 6mm Remington against a tree, he found to his chagrin that the thin crosswires and half-inch dot in his 12x Redfield Master scope didn't stand out as sharp and clear as they had in the hayfields of summer. He admitted he had trouble even seeing the dot. He didn't get that buck because he didn't have the right scope for that type of hunting. He had failed to realize that his 12x Redfield was primarily designed for varmint shooting. Nothing about it was ideal for the type of big game

hunting he was doing. It's a super scope, but not for all types of hunting.

This leads me to make the statement that there is no "all around" scope. Hunters face different types of terrain and shooting situations. It's impossible to have one type of scope that handles every hunter's problems. I'm aware that a 4-12x theoretically will meet the needs of many rimfire squirrel hunters, varmint shooters and big game hunters. Nevertheless, while this seemingly all-purpose scope can be used in most any hunting situation, it would have many drawbacks for some riflemen (imagine a rimfire shooter having a full size 4-12x on a Marlin 39A), and the higher power settings would serve no useful purpose for the vast majority of big game hunters. The weight and bulk along make it unsatisfactory for a large segment of hunters. It can be focused for distances well under a hundred yards, so the squirrel hunter can have his choice of powers, but it still isn't designed for that purpose and its physical configuration would make it ungainly on rifles such as the little Marlin lever action.

I have a 39A topped with a 2-8x Bushnell Compact. The scope measures 9½ inches in length and weighs only 11 ounces. It's right at home on my old Marlin. Its only serious drawback is the lack of a focusing arrangement on the objective lens. On the higher powers, there is a bit of blurriness at ranges under 50 yards. Since I use the scope on both rimfire and centerfire rifles, I put up with this slight disadvantage on the rimfire squirrel outfit. If I decide to make it a permanent "squirreler," I will send it back to the factory to be focused at 50 yards.

Magnification is the main downfall for the inexperienced scope user. A feeling prevails (remember my irritating friend) that you can't have too much power. Don't buy that song. Through the years, I've been down that road several times and can tell you it's a wise hunter who buys only the magnification needed. Woodchuck hunters are the worst offenders. Some seem obsessed with power. I can't be too critical of others on the point, as I was a strong advocate for high power when I switched from the rimfire to the centerfire chuck outfit. To show you to what extremes I went to, I purchased a 24x Fecker 1⅝-inch scope for a Model 70 Winchester 220 Swift. To complement the 24x, I also latched onto an excellent set of used Marine binoculars. I can't remember the power but know they were either 16x or 20x, so I was assured ample magnification. Was I ever.

My first trip to the pasture fields was probably the brightest evening during the entire year of 1950, and when I got set up I figured I could see 'em a mile away. Unfortunately, I was looking east to west, and as most woodchuck hunters know the sun sets in the west. Under those conditions, it's difficult to use even low power optics. The direct sun rays soon taught me

The late Will Johns, left, longtime editor of *Pennsylvania Game News,* used 2-7x Weaver on his 308 to take this forkhorn. Above, my son Tim does some practicing with his 3-9x Weatherby-scoped M760 Remington, a fine woods outfit.

a lesson about too much power. After fifteen minutes of intense glassing a stake and rider fence some 400 yards distant, it felt like someone was using a jackhammer right between my eyes. Another ten minutes only increased the pounding inside my head. I knew there were chucks in the fencerow, and I stubbornly went at it again, which only made the jackhammer operator turn on more air. Finally, I made out the blurry image of a chuck stretched out under a fence rail, but it skedaddled before I could raise the Swift. Another search with the big glasses increased the pounding to a machine gun tempo, along with opening the tear ducts. I had to give up.

While wiping tears and resting my eyes, a chuck's head appeared less than a hundred yards from me. I normally don't take such short shots, but I had to get something out of this. I didn't bother looking through the binoculars since I could see the chuck through my tear-drenched eyes. I leveled the big 24x, expecting to freeze the crosshairs on the chuck's chest, but he was gone. When I looked over the scope, the whistlepig was still visible. It took three attempts before I located my quarry in the scope, thanks to the less-than-five-foot field of view the 24x offered at 100 yards. The good news is that I got the chuck, but the bad news was that I had wasted money on optics that were essentially useless in the back pastures.

It took several more hunts before I gave in an realized that high magnification was not everything it was cracked up to be. The eyestrain, especially under those kinds of conditions, was unbelievable, and the small field made locating a target next to impossible. What I hadn't realized was that everything between a scope and the target is magnified. Instead of working for me, the excessive magnification worked against me. This doesn't suggest that either the scope or the binoculars was of poor quality; but neither was designed for what I was trying to use it for. The 24x Fecker was a target scope, designed for that purpose, and the binoculars were for military use. You might say that both were "special situation" optics. It was a costly lesson, but luckily I learned it early in my varmint hunting career. Since that time I have not been a strong advocate of unusually high power.

I have found in testing scopes and binoculars that the object viewed will look larger, but not necessarily closer. Certain weather conditions, like the bright sunlight I encountered with the high power binoculars, blur the target. Under ideal weather conditions, I've found that both of these factors could be relied upon; the target appeared larger and closer. That was proven to me later, when I installed a 10x scope on the 220 Swift and removed a chuck from the old stake and rider fence with one well-placed shot.

The desire for power causes many hunter to over-scope; that is, to have more magnification than the rifle can take advantage of. An example would be a 6-18x on a 30-30. Even a 3-9x or 2-7x isn't the wisest choice for this type of cartridge. The effective range of a 30-30 cartridge is under 250 yards, and I'm being generous with that estimate. Most of those who use a 30-30 hunt in thick cover. Dense stands of pine, hemlock and beech are home to the 30-30. Under these conditions, it's unlikely any shot will stretch more than 125 yards. When the range is short and the brush thick, a large field of view is far more necessary than a lot of magnifying power. The 1½-4½x variable, or a straight 2½x or 4x, works in these situations to the hunter's advantage.

In defense of the bigger variables, the argument is always put forth that with a wide range of powers the hunter has a choice. That's true, but it would be rare for a woods hunter to ever truly need such a scope's maximum power. I pointed out how difficult it was to find game in the 24x's small field of view. You can't compare chuck hunting with deer hunting, either. Chucks are all over the place, and few hunters get even mildly excited when shooting at a chuck. That's not the case when a buck is spotted. Even experienced deer hunters feel they are working against time. Get the shot off as quickly as possible, any delay can wipe out the chance, or so most hunters believe. To think that way is only human. A friend of mine saw a buck step out of a woods 200 yards away and start running across a hayfield in his direction.

Instead of being patient for a moment to let the buck come closer, or perhaps even stop, my hunting pal began to fire. His first shot, a miss, sent the buck hightailing into the woods. That's when my friend realized he had blown a made-to-order shot.

The unaided eye doesn't need as much help as most of us think. A hunter with 20-20 vision sees very well, even at 250 yards. On normal shots, even a plain 2½x is sufficient optical assistance. I know this will ruffle the feathers of a host of big game hunters, but a 4x scope will handle more than 90 percent of all Pennsylvania big game hunting.

I believe emphatically the statement I just made, but that doesn't mean all other types of scopes should be relegated to the ranks of the unwanted. Many hunters and shooters use a scope for more than just big game hunting, and that is where the variable power scope comes into play.

The advantage of the variable is its ability to adapt to a variety of shooting situations, not just to have a dual-purpose scope. Yet the hunter who feels a 4-12x will work equally well on his short-barreled 30-06 Remington pump and M77 Ruger 22-250 heavy barrel isn't necessarily right. He is looking at the lower range of powers for the '06 and the higher range for the 22-250. Facing the issue squarely shows that choosing a 4-12x for these two vastly different outfits is adding bulk and weight to the pump rifle, and a lot of unneeded working parts to the varmint outfit. In this case, my choice would be a 2½-7x for the 30-06 and a straight 10x or 12x for the 22-250. It would be a rare occasion to need more than 7x for big game hunting, and the varmint hunter will find a 12x about as much power as he needs in the pasture fields.

Several times, in gun articles, I have advocated to the handloader/varmint hunter the advantages of wide-range variable power scopes like the 6-24x Bausch & Lomb. My thinking on this particular setup is that the varmint hunter can successfully use powers up to 12x in the field, and the higher magnifications for load testing on the bench. This is one case where this type of variable can serve two distinct purposes on one rifle.

The variable power scope is somewhat misunderstood. First, it is not exactly a new kid on the block. European scope designers toyed with the multi-power scope long before Hitler marched his armies into Poland. In fact, Zeiss had several low power variables in the early '20s. The first American variable I recall was Bausch & Lomb's 2½-4x BALvar, which was available by 1950. It was built on a straight one-inch tube and, as with several other B&L's of the time, had no internal adjustments as it was intended to be used with their Custom mount of that era. In essence, that mount was a set of adjustable opposing cones to which the scope was held by a spring-loaded plunger. Turning the front set of cones adjusted for windage, the rear one for elevation.

That scope didn't seem to attract a wide following, but B&L's next variable, the 2½-8x BALvar 8, certainly did. It featured a 40mm objective lens and what was called a Tapered Cross-Hair reticle; actually it was a metallic deposit on a plane lens. This was an attempt to get around the problem of the too-conspicuous reticle which appeared when the magnification of a variable was increased in those days. This reticle subtended about one-third minute at its intersection, an amount that remained constant no matter what its power because it was situated in the front focal plane. However, due to the reticle's shape, and the fact that the field reduction as power was increased blocked out the thick outer ends of the reticle, the so-called Tapered Cross-Hair appeared approximately the same size at all power settings.

The BALvar 8 was a top quality scope, providing an excellent target image at all powers. It was also a strong and durable unit — as shown by some sales reps' gimmick of opening a gunshop door and sending a BALvar 8 bouncing and skittering across the floor, to the amazement of any loafers inside. At least it got their attention.

About the same time Weaver got into the variable act with their KV model, a 2.7-5x. It had only the two settings — that is, it was not continuously variable — and changes were made by turning a dial located beneath a cap just to the rear of the windage adjustment.

I had only a passing acquaintance with Weaver's KV, and have seen only one or two early European variable power scopes. In every early variable I saw, the reticle seem to grow larger as the power was increased. This was the case with the first American variables, too, and undoubtedly was the characteristic most disliked by shooters here. Actually, the reticle did not subtend any more at top power than at bottom — the target size grew just as the reticle did — but it became more conspicuous and therefore more annoying. This situation occurred because the reticle was placed in the first focal plane, so when magnification was changed by moving the erector system behind that plane, the appearance of the target and the reticle both changed together. This system did have one big advantage: there was never any shift in point of impact due to a change in magnification because both target and reticle changed together.

Nevertheless, most American shooters were bothered by the magnifying reticle and a lot of them complained about it. Redfield was the first company to do anything. In the late '50s they moved the reticle back to the second focal plane, which meant all the machinery which altered power was located ahead of it. Thus the target's apparent size was affected but the reticle's wasn't, so it appeared to grow smaller as power was boosted, larger as power

was decreased — which was just what the shooter wanted. However, because the reticle wasn't in the original focal plane, any imperfection in the power-switching system could cause some change in point of impact because the reticle did not move along with the image. This was a problem for some years, especially with the lower-price scopes, but current models have largely eliminated this. Designs, materials and construction have simply improved over the years, so today's models are far superior to those of just a few decades ago.

But with all the variable power scope has to offer, it is not a panacea for all shooting problems. Scopes, like sports shoes, are designed for special applications. You won't find a baseball player using hiking shoes. An 8-point saw (8 teeth to the inch) can be used to shorten a stock, but a stockmaker prefers a saw with finer teeth. Scopes, like saws and shoes, are designed for a particular purpose. A good variable power scope will satisfy almost any hunter's needs, but for only a few dollars more than the variable power cost, the hunter could have two types of straight power scopes specifically designed for the rifles and cartridges being used. Also, there is the time consuming work and expense of changing a scope from one rifle to another. The hunter who isn't a handloader and doesn't have easy access to a range will not benefit all that much from a variable power scope if he intends to use it on several rifles.

The proper way to pick a scope is to assess your needs. How do you hunt? Where do you hunt? What is the normal shooting distance where you hunt? Is the scope strictly for one rifle, or will it see use on several? What magnification would best fill your particular needs? Is a restricted field of view a disadvantage? This question may get an automatic yes, but that's not necessarily so. The varmint hunter knows that with the high power scope he wants to enlarge a distant target, the field of view will be smaller. But this is not a problem for the chuck or prairie dog shooter, as he is shooting at a stationary target. A wide open pasture field or prairie is a different ball park from the one the deer rifle is used in. A large field of view is essential for the brush hunter. He faces enough obstacles without having to contend with a small field of view.

With all the advances in scope making, are all scopes equal? No, and they never will be. Don't be lulled into a scope deal just because of a low price. A high quality scope is a precision instrument. It requires expensive components and skilled workmanship to build a scope that will perform flawlessly over a long span of years. Such a scope is a long-term investment. I'm still using several varmint and target scopes from the 1950s, and I don't expect them to fail.

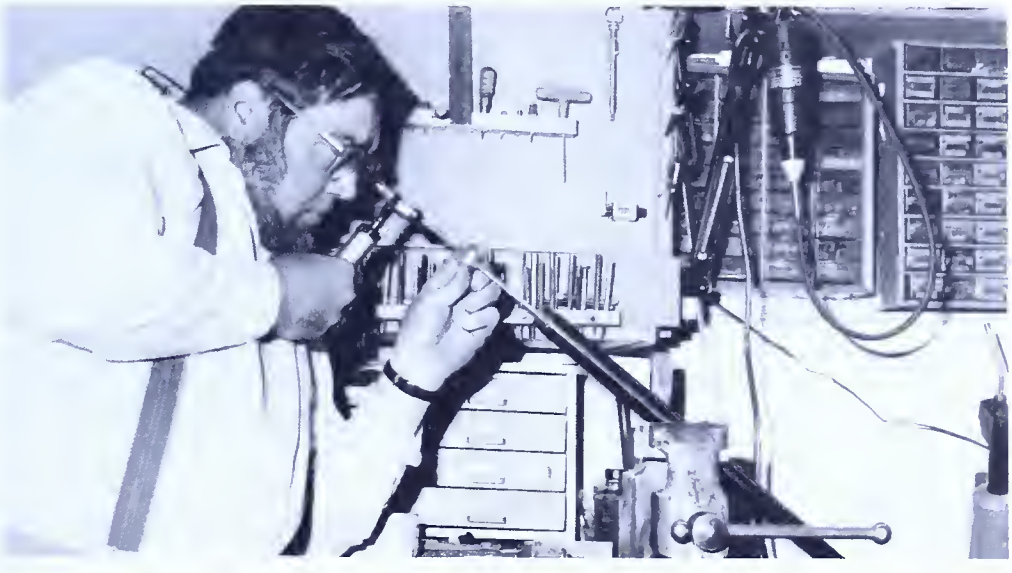
I'm all for keeping a scope simple. I'm not interested in gadgetry. I'm not implying that rangefinders and lighted reticles can't be used in some situations, but I can't recall a situation in Pennsylvania big game woods where either would have been useful to me. I can understand the Western hunter's need for a rangefinder. Mountains and prairies are vastly different from the dense forests of Pennsylvania. This is only one man's opinion, but it's founded on many years of scope using and testing.

I mentioned one incident with a reticle that hadn't been designed for the purpose it was used for. Many new scope converts do not realize the important role a reticle plays. Primarily it is an aiming device, but its design and makeup are extremely important. A hunter or shooter should give serious thought to picking the proper reticle. That's nearly as important as choosing the right scope.

In the early days of scopemaking in America, the aiming device, reticle, was often spelled reticule. In England, it was called graticule. You can choose what suits you. I stick with the shorter spelling, probably because I'm lazy and, since the vast majority of gunwriters use "reticle," I assume it's either correct or they also are lazy.

There seem to be nearly as many designs of reticles as there are brands of scopes. I have never figured out why so many are needed. The plain crosswire used in most older scopes is still tough to beat. Over the years, the crosswire

Gunsmith Joe McCrea uses another kind of optical aid, a borescope, to check the interior surface of a heavy varmint barrel.



(often called crosshair) has seen a number of innovations. The most popular version nowadays comes under the heading of "plex." This type of reticle has what looks like four posts running almost to the middle, and thin intersecting wires in the center. With such a reticle, the hunter can center his target under all types of light conditions.

The tapered reticle helps guide the eye to the center of the reticle. At the intersection in the center, each hair is very fine. Going outward from the center, the wires increase in width. Each serves as an arrow, guiding the eye toward the aiming point, even against dull or dark backgrounds.

Leupold's popular "duplex" version has thick rectangular bars coming in from the four cardinal compass points and thin wires at the intersection. The bars are visible in the worst light and the thin wires at the intersection facilitate precise aiming.

Some of the reticles in the use today are crosswire, post and crosswire, duplex, crosswire with dot, rangefinder, and numerous variations of these. Crosshairs are made from stainless steel wire, alloys of brass, spider webbing, silk, spun glass, tungsten and metallic deposits on a flat glass lens. There is no shortage of reticles but, from a logical point of view, many of these are just more of what I call gadgetry. I do appreciate the plex reticle on big game rifles. I like it because the reticle can be seen instantly, and the eye has little trouble finding the intersection — which is important because shooting conditions in big game season are not always conducive to good vision.

The thickness of the wire at the intersection determines how much of the target it will cover or subtend. A really fine wire might subtend no more than 1/4-inch at 100 yards. That's too fine for big game. I used a 4-12x with this setup several deer seasons ago and couldn't find the intersection late one afternoon due to the gathering shadows. This scope was designed primarily for varmint hunting. I must admit the four heavy bars helped guide my eye to the center of the reticle but I couldn't place the intersection precisely. This type of reticle is not for big game hunting.

The dot reticle has gotten a lot of attention in big game scopes in the last half-century. A dot reticle should be approached with caution. It has as many liabilities as assets. The proper size of the dot depends on what the scope will be used for. A tiny dot in a big game scope is a mistake. Dots are listed by how much they subtend at a 100 yards. A one-inch dot (often referred to as one-minute dot) covers one inch at a 100 yards, which means it covers 1/2-inch at 50 yards, 2 inches at 200 yards.

The big game hunter wants no less than a 2-minute dot in a 4x scope. A dot any smaller than that is hard to see when light conditions are poor. This size

A straight 4x is hard to beat for most big game hunting as it offers an excellent compromise between magnification and field of view. It also looks appropriate on rifles the size of this 336 Marlin.

dot covers a lot of the target at super long distances, and that can be a definite drawback. The brush hunter with a 35 Remington or 30-30 will be better off with at least a 5- or 6-inch dot. When shooting in heavy vegetation or dark stands of timber, an even larger dot is advisable. Experience has proven to me that in most cases the big game hunter selects a dot that is too small.

Each type of hunting requires a different size dot. For instance, a long range woodchuck hunter with a 10x or 12x scope can use a 1/2-inch dot, but it might present problems beyond 300 yards. A wiser choice for long range would be a 1/4-inch dot. On a 400-yard shot, the 1/4-inch dot would subtend only one inch, which allows a hunter to aim precisely.

For squirrel hunting, nothing beats a one-minute dot. At normal 45 to 50-yard shooting distances, the one-minute dot covers roughly a half-inch. I can fit a half-inch dot behind the shoulder or smack on the neck. I have a 6x Unertl target scope that carries a 3/4-inch Lee dot. I can use it successfully on a 22 rimfire for squirrel or on a Hornet or Bee for chucks. It's about as close to a happy medium as I have ever found.

T. K. Lee installed two dots in a 6x Redfield Widefield for me. A 2-inch dot decorated the intersection and a one-inch dot was place six minutes of angle below the center dot. This serves two purposes: for rangefinding, and as a long range aiming point. It's also possible to have a dot for each 100 yards, but that's not the exact answer to long range shooting problems it might seem to be. Temperature and humidity can play havoc with a bullet's flight, and there are other factors such as mirage and wind. The two-dot system worked for me, and I wouldn't want more dots unless I was specializing in one type of hunting such as woodchuck or prairie dog shooting. Let me warn you that it takes some time to adjust to a multiple-dot setup. Two should be plenty for a starter.

A dot has some distinct advantages. It can be used for rangefinding purposes, and it certainly is an asset to the hunter. If of reasonable size it keeps the intersection from fading as the eye tires, a common problem facing many hunters.

The traditional crosswire reticle automatically indicates the aiming point. You might say it's self-explanatory, even to a novice shooter, whereas the post can humble even veteran shooters. The main question I have encountered is, "Where do you hold a post?" This isn't obvious because the post usually projects above a horizontal wire, and that confuses many. The answer is simple; just use a six o'clock hold — the same hold used with a blade front sight and an aperture rear.

The redeeming feature for the post is its conspicuousness in poor light conditions. No one can deny that a post stands out like a sore thumb. Even weak or failing eyes can see a post. My objection to the post is the same as with the full buckhorn: it blocks the shooter's vision. Bushnell once corrected this problem by utilizing a post that could be flipped up or down by using a tiny lever on the windage adjustment. The neat part of this was that the post covered only the bottom part of the vertical crosswire; that is, it did not extend above the horizontal wire. This kept the aiming point exactly where the eye expects to find it.

Probably the duplex, or some minor variation of it such as the Dual-X, 4-Plex, Multi-X or Quadraplex, to name a few, ranks number one for big game hunting. Still, some degree of caution has to be exercised when selecting the duplex reticle. While the various makes appear to be similar, they aren't identical. Some have thicker bars or arms at the edges, and this could be important in poor light conditions. The distance the bars or arms travel toward the center is also important. In severe light conditions, the thin wires at the intersection may disappear, as they did for me with the 4-12x, but when the arms are thick close to the center, the shooter still can place the shot — if they don't obsure the target.

I can offer all kinds of advice on how to select the proper scope, but the ultimate decision is yours. My suggestion is to determine your needs, buy the scope that fits those needs, and buy a scope with the idea it will outlast the rifle. That may be stretching a point, but today's scope is a far cry from the products of the 1950s. Fogging is gone, multi-coated lenses sharpen the image, and reliability is built into the better grade of scopes. The properly mounted scope is a hunter's best friend. But proper mounting is another subject that is worth taking a close look at.

Scope Mounts

IN THE EARLY days of the optical sight, European gunbuilders looked on the scope more as an accessory than an essential piece of equipment. Hence, their mounting setups ran in the quick-detachable class, but not the type we have today. As a rule, such mounting setups were more detrimental than helpful. Gunbuilders overseas styled their rifles for open sights. They apparently didn't have a lot of faith in the optical sight, so most mounts were high enough to see the open sights under the scope. This made the scope difficult to use, and various methods were designed for removing the scope quickly.

These setups were high and heavy. Worse yet, they seldom returned to zero when the scope was removed and replaced in the field. To add to the hunter's woes, most European scopes had no internal windage adjustment. Eventually, a windage adjustment screw was incorporated into the rear mount, but often the front ring was solid and could not move. This meant that windage was accomplished by bending the scope tube slightly. I am not certain when scope builders got around to putting both windage and elevation adjusting devices inside the scope, but it probably was in the late 1920s or early '30s. American scopemakers led in this improvement. The 1931-32 A. F. Stoeger's Arms and Ammunition catalog lists a Hensoldt 2¾x complete with windage adjustment. In fact, the old catalog points out that "By the use of this simple windage adjustment it is unnecessary to embody in the mount the regular windage make-up, and this of course lessens the cost of the mount and makes a much better job in every detail."

When shooters and hunters began to see the many advantages offered by the optical sight, the "accessory only" theory lost ground. It took time, but American hunters began to install a scope with the intention of using it as the main sighting arrangement. That is the way it should be. Nevertheless, a

segment of today's hunters still won't or can't accept the fact that a scope is dependable under even severe hunting conditions. They continue to use quick detachable, see-through and swing-over mounts. They install a scope with the preconceived belief that it will fail and they will need open sights to fall back on. I can't see this type of thinking as the proverbial "ounce of prevention." To me, it's defeating the purpose. During the last ten years, I can't recall having a serious scope problem. Nothing that would require removing the scope. I want my scope mounted as low as possible, and directly above the action. It never occurs to me that the scope will fail.

It seems to me there has been more gimmickry in scope mounts than any other aspect of shooting. European mount makers apparently felt the hunter would have problems with his scope, hence the early high detachable mounts. In this country, it was soon learned that installing the scope low on the receiver made it more efficient. With such a setup, the scope's line of sight is close to that of the open sights. Early hunting scopes didn't have large objective lenses, and that permitted mounting the scope only a half-inch or so above the open sights. Today, with the large objective lens typical of many variable power scopes, mounts have to be high enough to prevent the front lens from touching the barrel, and this results in a high mount.

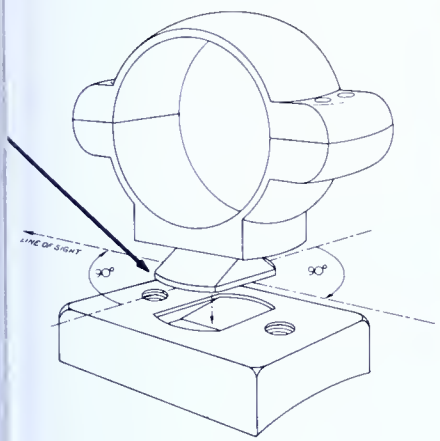
When I used the word "gimmickry," I wasn't trying to be facetious; it's true that there are a variety of scope mounts, and many of them are designed to lift off, swing-over or see through. In other words, don't put too much faith in the scope, because sooner or later it's going to fail.

A large segment of hunters implicitly believes this. I know one owner of a Savage 99, with an old Echo quick detachable mount, who removes the scope and carries it in his hunting coat when it rains. Even though the scope is a fine Leupold 4x, he is convinced no scope is waterproof. That's not true. Today's good quality scopes are waterproof for all practical purposes.

Mounts fall into two basic classes — fixed and detachable. I'm not certain how the scope manufacturers categorize them but, from my viewpoint, any mount that requires tools to remove comes under the fixed type, and those that allow scope removal by pushing on a spring-loaded plunger attached to the ring clamp setup, unlocking the mount with side levers, or swinging it to the side fall into the detachable category. I'm aware that some mounts are called quick-detachable, such as the Jaeger Quick Detachable side mount.

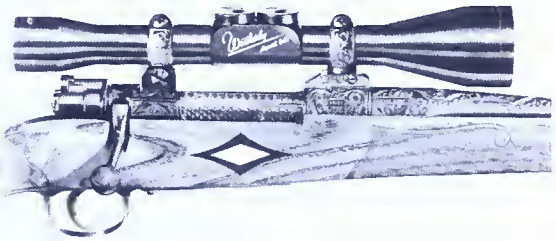
During the 1950s and '60s, swing-over mounts gained some popularity. At that stage in the scope game, the danger of fogging was a fact of life, and to some hunters the swing-over mount was considered a necessity more than a convenience.

Weaver had their Pivot Mount and Redfield a Quick-Switch pivot mount,

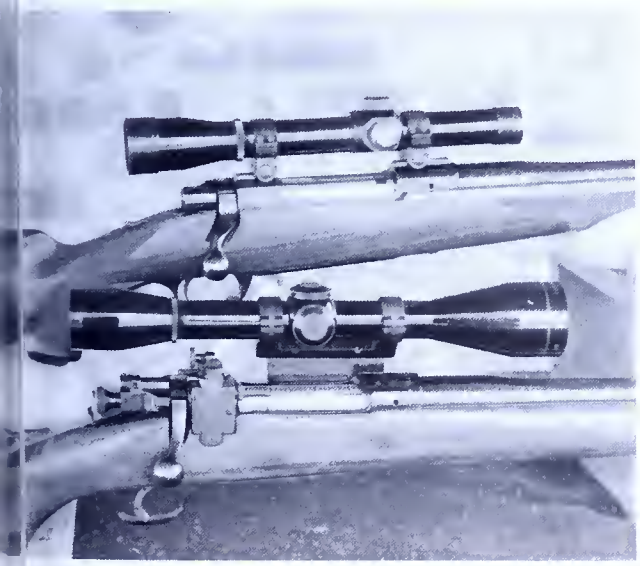


Detail of Redfield Jr. rotary dovetail connection is shown at left. This, plus opposing windage screws at rear ring, make it easy to get horizontal adjustment. Above, Val Kovach with Redfield-mounted Schmidt & Bender scope on 338 Magnum Mauser.

S&K Instamount, left, makes it easy to install scope on military rifles such as this 1903 Springfield. Below, Buehler 2-piece mount works fine with Weatherby scope and rifle.



Low-mounted scope on M77 Ruger, top, contrasts with high mount on Springfield which permits use of aperture sight below 10x Leupold. Some hunters want instant availability of iron sights, so sacrifice some of scope's efficiency to get it.



Double Lever mount designed by Len Brownell and now available from Kimber permits quick scope removal and accurate replacement.

but the most famous of all was the Pachmayr Lo-Swing mount. Pachmayr had both top- and side-mounted versions, and there were probably others I have forgotten.

I installed dozens of swing-over mounts, but I always felt they were weak. Basically, the scope ring clamps were secured to the base by spring clips when the scope was snapped back on the base. I found that these clips should sometimes get bent or the tiny screws that held them to the scope ring clamp would loosen. Either of these mishaps would allow the scope to bounce loose when the rifle recoiled. Also, the hinge screws could work loose when the scope was swung back and forth, and one or both clips would lose its grip on the base. After working with this problem, I made certain the spring clips were evenly attached to the base and then tightened the hinge screws almost to the point where it was impossible to swing the scope. I always cautioned the owner not to swing the scope unless it was absolutely necessary.

In recent years the see-through mount has appeared on Pennsylvania big game rifles by the thousands. This type of mount is available from several manufacturers under several names, but the basic principle is the same — a set of figure 8 rings, the top holes for the scope, the bottom ones to provide a view of the open sights. Many hunters say the see-through mount is unbeatable. I won't argue the point, but feel obligated to point out that using such a mount the scope sits very high, which makes it difficult to use.

There is some argument over whether the one-piece base such as the Redfield Jr. is superior to the two-base setup. The one-piece base fans argue that as the action heats when a series of shots is fired, it begins to expand, and when using a two-base setup, the scope is stretched. They say the one-piece base will absorb some of the expansion and thus not as much strain will be put on the scope.

As a gunsmith, I leaned toward the two-base setup, but I have no complaints whatsoever against the one-piece base. I always thought the two-base setup was a little easier to adjust, but that's just my opinion. There are some minor drawbacks with each type of mount, and it's worth mentioning several.

On one-piece base setups such as the Redfield Jr. the front ring has a dovetail stud on it that fits into an opening in the front of the base. The stud is placed in the dovetail and rotated 90-degrees. They are designed and made to fit tightly. Never use the scope to rotate the front ring. Use a short length of padded steel rod or a round piece of wood. When the ring is turned to the proper alignment with the base, remove the top half of the ring and install the scope. At the rear of the base, opposing windage screws engage semi-circular cuts in each side of the rear ring and lock it solidly. By loosening one screw

and tightening the other, windage adjustment can be made. I use these screws in the mount to get the windage adjustment very close before taking the final few clicks on the internal windage wheel. This keeps things close to the optical center of the scope, and that's where you get the best image. It's possible to get windage right on the button with the mount screws, but never try to get the final fraction of an inch by tightening one screw without loosening the other. Care must be used when tightening the rear base adjusting screws as a screwdriver offers a great mechanical advantage. If too much force is used, it's a problem. The screws should be tightened firmly but not excessively against the base. It's best to just get close with the mount screws and use the internal adjustments for the final setting. It's also advisable not to use a screwdriver for tightening the mount screws, as it can have too much mechanical advantage. A quarter turned with the fingers only will do the job and save problems.

It's not a wise idea to continually remove and replace this type of scope mount. In time, both the front ring stud and the dovetail in the base will wear, allowing some movement of the scope which makes sighting in the rifle next to impossible. Also, the front right stud can rust solidly into the dovetail. To prevent this, wipe a light coating of an anti-seize compound on the stud and around the top of the dovetail slot when mounting the scope. This eliminates any rust problems.

Undoubtedly, the best base is Sako's integral tapered dovetail type, but in all honesty I have rarely encountered a problem with any design that was installed properly.

The type and brand of scope mount is a personal matter. Any of the high quality mounts such as Buehler, Leupold, Williams, Weaver, Jaeger, S & K Insta Mounts, Redfield and others will give a lifetime of service.

A good mount is rugged, precision machined, designed for the action it will be used on, and has some cosmetic virtues. Be selective; there's no point in buying a top quality scope and attaching it to a rifle with pot metal mounts. Don't be lulled into thinking any mount is just a set of rings and bases. It's just as important as the scope. If it allows any scope movement relative to the gun, even under extreme recoil, you're not in zero anymore. So give serious thought to this part of the shooting setup. When properly mounted for the user, there will be fewer problems sighting in.

Shotgun Basics

THE SHOTGUN HAS never enjoyed the popularity of the rifle. In a sense, it has always played second fiddle. The shotgun doesn't have the impressive past of the rifle. It has never been a major weapon of the military. It didn't tame the frontier or pave the way to the West. The rifle did, and time has embellished its deeds. The rifle defended the frontier, put meat on the backwoodsman's table, and cracked with deadly authority along the Santa Fe and Oregon Trails. From the battle of Bunker Hill to the rice paddies of Viet Nam, the rifle spoke for freedom. Who can deny the rifle a prominent place in American history?

Much of the time the rifle was surrounding itself with accolades gained on the fields of battle and in the hunting woods and fields, the shotgun stood in the wings. Hampered by its ineffectiveness much beyond 50 yards and unable to guide its pellets with the accuracy of the rifle's bullet, the shotgun's primary use is for short range hunting of moving targets such as small game and waterfowl, and for breaking sailing clay saucers on the skeet and trap fields. These functions are not necessarily mundane, but they certainly lack the luster and prestige to make the shotgun an important instrument in mankind's epoch struggle to conquer the land and live in peace.

The shotgun differs from a rifle in that it is almost always a smoothbore, the rare exceptions being the rifled barrels that some manufacturers are offering for use with the rifled slug. Unlike a rifle which fires a single projectile, the shotgun fires a shot charge consisting of many lead or steel pellets. This makes the shotgun a short range outfit, as the velocity of these small pellets falls off quickly. As the shot charge moves away from the barrel, it expands fairly evenly into what is known as a pattern. Most hunting shots are well under 50 yards. It's not logical to expect a shot charge to have enough velocity and energy to be effective on live targets at 60 to 80 yards, as is often claimed.

The rifle is capable of making precise shots at long ranges, but the shotgun has no reason to be equipped with a sophisticated aiming setup. With a shotgun, it's basically point and pull on moving game, the expanding pattern making up for small pointing errors.

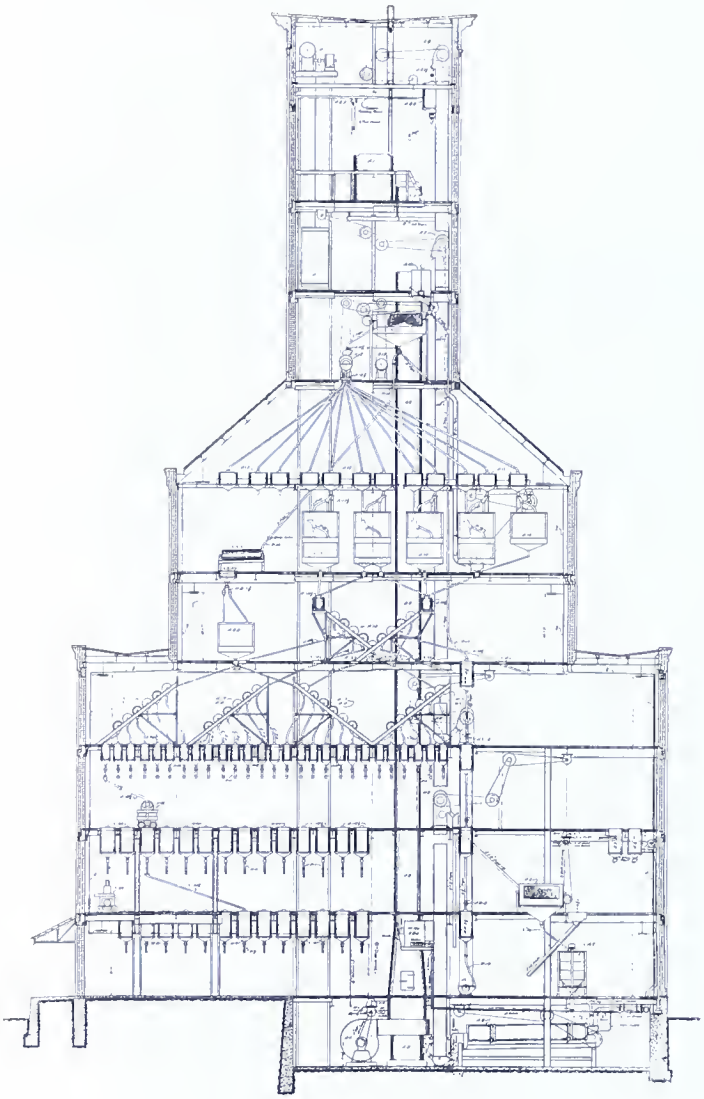
The large patterns lead some to think it's impossible to miss with a shotgun, but every shotgunner knows that consistent hitting with a smoothbore requires a large degree of skill. As one old-timer put it, "There's more space around a grouse than on it." The shotgun is vastly different from a rifle and, in truth, it should be.

Pinpointing the exact date, or even time period, that the shotgun made its debut is next to impossible. Some historians believe the shotgun arrived during the early years of the flint ignition system. I'm not disputing this, but am inclined to believe that multiple small ball charges were used long before the flint and steel ignition system hit the scene. Not all analytical minds belong to inventors, scientists, researchers and ballisticians. The military is supposed to be the dominant force in firearms development, but a hunter who fired into a flock of sitting ducks with a single ball from cumbersome matchlock may have come up with the idea that two or three smaller projectiles would increase his chances for success. Now, I'm not implying that the matchlock was a commonplace sporting outfit. That might be going a step too far. But since it would drop an enemy soldier before he could get within spear-throwing distance, it's reasonable to assume some early harquebuses were used for hunting, even though they were normally fired from a support.

If the flint ignition system was a primary impetus in bringing the shotgun to fruition, it also had several drawbacks that were serious disadvantages to the shooter. First and foremost was the lag time between the two ignitions. Flintlock rifle hunters know a steady sight picture must be held through the flash of the priming powder and until the main charge is set off in the bore. That isn't easy to do, but it can be mastered in relatively short order on stationary targets. However, the wingshooter or rabbit hunter must do this while his quarry is moving.

Another aspect that made a perfect follow through difficult was the uncertainty of black powder ignition and efficiency in the mid-1600s. For all practical purposes, the ingredients back then were pretty much the same as used today, but the percentage of each, plus the quality and consistency of the black dust, was far from the reliable mixture today's flintlock hunters use.

While stating an exact date when the shotgun was born is impossible, the fact remains that it had achieved considerable recognition as a fowling piece



This 10-story, 167-foot tower began producing shot for Remingtion-UMC on February 10, 1910, using the "drop" process. It is now owned by RemGrit Corp. and is regularly producing shot for several of our domestic ammunition manufacturers. Molten lead is poured into steel pans and drops through tiny holes into water 133 feet below. Imperfect pellets are separated by "tableing' — rolling the shot over slanted glass tables. Only spherical pellets gain enough speed to jump a gap; those that are out of round are routed back for re-melting. Proper size pellets are then cleaned, polished and graphite coated before being stored for later loading.

by the time the percussion cap replaced the flint. Many early flint shotguns show the artistry of European gun builders. Ornamentation and silver and gold inlays didn't help the efficiency of the flintlock fowling piece, but the skill and craftsmanship involved made some of these fowling pieces pure works of art.

By the end of the 1600s, the shotgun was gaining its own identity. Undoubtedly, the smoothbore musket was used with either ball or a type of shot, but the 1700s had barely gotten underway when a new surge of interest in shooting at flying targets swept through the hunting ranks. Shot such as we use today was unknown, but a version known as "swan drops" was used. These were cast in a mold and were fairly large, weighing around 30 grains each. A pound of lead would yield about 225 swan drops. That comes out to about 14 swan drops per ounce, which is close to the 11 per ounce of No. 1 buckshot. It's easy to see the pattern would not be too dense. Swan drops fell by the wayside when, around 1769, William Watts, a plumber by trade, devised a method for making round shot. His method was simple. Molten

lead was poured through a sieve, and the droplets of lead fell into water. I imagine Watts settled for anything that came through the sieve. Today's shot tower works on a similar principle, but since many of the droplets are far from round, the shot pellets are sifted and screened to size.

As recreational shooting became more popular, the shotgun began to get more attention, and during the mid-1700s a two-barrel shotgun entered the scene. Around the same period of time, shotgun design came under scrutiny. The long barrel, full stock outfits were heavy and cumbersome characteristics not conducive to good hunting, so gun builders began making shotguns with short forestocks and shorter barrels.

The shotgun was still a front-end loader but, as the year 1800 approached, Henry Nock, a celebrated English gun maker, came up with an idea that would revolutionize shotgun ignition. Until now it had taken considerable time to ignite the main powder charge. Nock's idea was a short channel incorporating a small ignition chamber. This would guarantee that the main powder charge would be ignited all at once. Earlier, the main powder charge had often been started up the bore by the detonator, and ignition was erratic. Apparently, a number of ideas were tried, but the main goal was to ignite the main powder charge instantly. This increased the force of the main powder charge, allowed shorter barrels, and increased the effective range of the shotgun.

The flintlock shotgun was deadly in the hands of a good wingshot, but it was still plagued by ignition problems. All the improvements in powder manufacturing and ignition systems over the years had made the flintlock an efficient weapon when all conditions were right, but it was still subject to misfires.

The Reverend Alexander Forsyth in the early 1800s discovered that some chemical mixtures could be detonated on a hard surface when struck a sharp blow, much the same principle as used with today's cap gun. Forsyth deserves a fair share of credit for changing the thinking about ignition systems at that time, but it was Joshua Shaw who created the percussion cap which fits over a nipple that leads to the main powder charge. It's easy to assume that this dramatic step would be like turning on a light in a dark room, and that every gun builder would instantly change to the new system. That was not the case, although the benefits of the percussion cap were so obvious that most gun makers did adopt the system. But it took several decades. The same battle is going on today between the typewriter and the word processor. The diehard typewriter fan claims there is no equal to his old Woodstock or whatever, while a person trained on a word processor thinks that attitude is absurd. Since I was a typewriter repairman for a short period

and worked on a variety of makes and models, and I now have more than five years' experience on word processors, I feel qualified to state unequivocally that I would quit writing if I had to go back to a typewriter.

Shaw's little cylinder with its tiny amount of fulminate finally brought a high degree of reliance to the black powder firearm. No longer did the hunter have to wrap a cover over his ignition system to protect it from the elements. Gone were the days of lost priming charges, damp powder in the bore, and misfires. The percussion cap made the front end loader dependable regardless of the elements.

The percussion cap's longevity was short-lived. The concept of breechloading was not new when the percussion cap came onto the scene, but failure to perfect a breech seal (where the barrel and action come together) kept the muzzleloading firearm alive for another half-century.

During the reign of the percussion cap, gun makers were experimenting with selfcontained cartridges. Lefaucheux, a Parisian gunsmith, finally solved the problem of gas leakage. At least, some historians credit him with making the first gas-tight cartridge. He designed a breechloading action that used a pinfire cartridge and was a major stepping stone in the birth of the shotgun. His design had a locking lever underneath the forearm that swung sideways to release the barrels and allow them to tip downward. Crude as it sounds, it was superior to all other designs of the time and proved that loading at the breech was now a reality. The shotgun had made the transition from a front end loader to a reliable breechloader. The vast assortment of components and accessories needed to fire to muzzleloader would be replaced by a single shell.

I might point out that the brass-headed paper-tube pinfire cartridges used in Lefaucheux's shotgun were not nearly as efficient as today's shotshells, but they were the direct ancestors of what you and I stuff into our shotguns.

The black powder era was fast coming to a close. It would enjoy a few years of use in breechloading firearms, but smokeless shotshell powder entered the scene around 1864 and sounded the death knell for the sulfur, saltpeter and charcoal mixture. We should note that black powder didn't roll over and die when smokeless was invented. When I was a youngster, dogging rabbits for my brothers in the early 1930s, the Romax black powder shell loaded with drop shot, which is very soft lead, was still popular. Those were the Great Depression years, so the reason for this shell's popularity might have been its price; a smokeless powder shell cost nearly two cents more.

The shotgun as we know it today dates back to 1851, when Charles Lancaster in England invented an improved breechloading, centerfire model. Firearms historians may take issue with my philosophy, but I feel so

many people around the world were involved in gun making that often it's impossible to say this one or that one deserves exclusive credit for some development. In fact, the development of all firearms was the work of numerous individuals. The age of industrialization had not yet arrived. Little by little, the rifle evolved into an efficient tool for long range shooting while the shotgun, as a fowling piece, made its debut later.

A smoothbore musket could fire a single projectile or a multiple shot charge. One thing was obvious from the very beginning: the shot charge was for short range shooting only. When rifling was discovered some 150 years after gunpowder came into common use, more emphasis was put on accuracy. With a single projectile, the smoothbore was inaccurate, to say the least. With such a projectile spinning rapidly from a rifled barrel, the shooter was able to place his shot, even at considerable distances. The separation between the single-projectile rifle and the multiple-ball firearm had begun. One firearm could not do both jobs efficiently.

As the shotgun developed, more attention was given to the shot charge. Around 1770, an Englishman named William Watts learned that molten lead would form into balls when dropped from a high tower into water. In the early days, mine shafts were used, but shot towers are the most efficient and are normally used for shot production.

To start with, the lead is melted and a small percentage of antimony is added to harden it. It is then cast into "pigs" and hauled up into the shot tower where it is remelted and poured into a shot dropping pan. The pan's bottom is really a sieve, with holes of a size to give the diameter of shot wanted. The pan is shaken constantly to aid in the breakup of the molten lead as it streams through the holes in the pan at about 700 degrees Fahrenheit. The droplets form into near perfect balls during the first few feet of what might be a 200-foot journey into a water tank. Contrary to popular belief, the water tank serves only as a cushion to prevent the shot from deforming when it hits. This deep tank of water has nothing to do with chilling or cooling the shot. "Chilling," as used here, is a term referring to the adding of the antimony. The shot is spherical and cool long before it hits the water.

Not every pellet is perfectly round. After the pellets are dried, they are tumbled for polishing and then are run by gravity over inclined glass plates for sorting. Perfectly spherical shot rolls down the glass plates with enough velocity to jump a scrap-gathering trough at the bottom. Imperfect shot falls into the trough and is collected to be remelted.

Pellets that survive the trip across the inclined glass plates and scrap troughs are ready for sizing. These pellets are run over inclined steel plates which are drilled with holes graduated in size. As the pellets roll over the

plates, they drop through the holes and are sorted into standard diameters. Now, the shot pellets are ready for a final polishing, and from that point they are binned according to shot size, bagged and shipped.

A final process for some shot is the addition of copper or nickel plating to protect it from friction as it passes through the bore. Only so much antimony can be added effectively to lead, and the plating of shot guarantees the hunter or competitor that less of his shot charge will be deformed in the forcing cone, the bore itself, and in the choke constriction. The more pellets that remain cylindrical, the truer they fly and the denser the pattern.

Naturally, William Watts' shot was not as good as today's product, but it was certainly an improvement over the mixtures of iron and lead that previously had been dumped into the barrel's innards. Watts' methods brought some uniformity to shot sizes. He knew nothing about the use of antimony for hardening lead or the advantages of sizing shot, but just making it fairly round was a distinct improvement.

The next major improvement in the shotgun's performance was the discovery of choke constriction. Here again, history reveals several names in connection with this — notably the Englishmen Pape and Greener — but from the American view Fred Kimble of Illinois really got the ball rolling about 1870. Kimble was a waterfowl market hunter, and somehow discovered that by reducing the bore slightly at the muzzle the shot charge would hold together better and thus kill more effectively at the longer distances. I have never read much about Kimble, and I have to say that some firearm historians claim Kimble didn't discover choke, that he merely perfected it to a high degree of efficiency. What's all the fuss about? Whether Kimble made the discovery or not is unimportant; he proved that muzzle constriction would add yardage to the effective range of a barrel, and that was a major milestone on the road to today's shotgun.

With wing shooting becoming popular in America in the late 1800s, the shotgun's looks began to change. Probably the most noticeable change was replacing the external hammers with internal ones. This feat of gunsmithing can be pinpointed to two Englishmen named Anson and Deeley, then employed by Westley Richards. They were issued a patent in 1875. External hammers on old shotguns may have a nostalgic effect on some modern hunters, but in brush and wet or cold weather, extreme care has to be used with them. Limbs and low hanging vegetation have an uncanny way of catching on a hammer and pulling it back far enough to discharge the gun when the hammer is released. Or in wet or cold weather, the hammer may slip from under the thumb during the cooking procedure. Anson and Deeley made an important contribution with their hammerless design.

Standard Shot Chart

No.	12	11	10	9	8	7½	6	5	4	2
DIAMETER IN INCHES	.05	.06	.07	.08	.09	.095	.11	.12	.13	.15
APPROXIMATE NUMBER OF PELLETS TO THE OUNCE										
	2385	1380	870	585	410	350	225	170	135	90

Courtesy of Winchester

The shotgun's barrel is not just a long tube of steel. Undoubtedly, early barrels were not much more than this, but about the same time that Anson and Deeley introduced the hammerless shotgun, other important steps were being taken on the shotgun road. Smokeless powder was replacing black powder and barrel makers were trying to solve the problems of putting choke into the muzzle.

The internal makeup of a shotgun barrel is complex. The breech end is enlarged to make room for the shell, and this area is called the chamber. Its rear circumference is relieved to accept the rim of the shell head. Ahead of the chamber is a tapered area called the forcing cone which reduces the barrel's internal diameter to the proper bore measurement for the gauge of the gun. From the front of the forcing cone to within a few inches of the front end of the barrel, the internal diameter or bore measurement is the same, or as close as it can be made by today's sophisticated barrel making machinery. In the last few inches of its length, there is some constriction in bore diameter, called the choke. The choke's purpose is to help control the diameter of the shot charge after it leaves the muzzle.

The rear end of the chamber is relieved to accept the brass rim of the shell head. Ahead of the rim cut the chamber has a diameter in 20-gauge of about .699 and runs a gentle taper of .005 (five thousandths of an inch) for each inch of chamber length. A 20-gauge with a 2¾-inch chamber would begin with a diameter of .699 and taper to .685. The taper aids in case removal.

In years gone by there was some controversy over whether the chamber should be the exact length of a fired case or about 1/16-inch shorter. If the chamber was shorter than the fired case, the front end of the case would unfold into the forcing cone, guaranteeing a seal to prevent gases from escaping around the wads and breaking up the shot charge before it entered

the forcing cone. The problem with this method was a higher chamber pressure. Also, the possibility existed that small pieces would be ripped off the case end and adhere to the bore proper. Subsequent shot charges hitting these pieces could bulge the barrel at that point. I have seen two barrels that were bulged this way. Any argument favoring the short chamber was laid to rest with the advent of the plastic shotcup/wad column. With this setup, the shot charge is unaffected by gas leakage.

In the early musket days, the gauge of a bore was determined by how many lead balls of the bore's diameter would weigh a pound. Sixteen balls meant the bore was a 16-gauge, while a "twelfth-pounder" meant a lead ball weighing one-twelfth of a pound would fit snugly in the bore. It's still common today to refer to the gauge of a shotgun as 12, 16 or 20-bore. There's an inconsistency here as the 410-bore is actually a .410-inch caliber.

I have heard that as many as 2000 brands of automobiles existed during the early days of car manufacturing. It seems that everybody and his brother got into the act. We are down to a mere handful of car manufacturers today, and we've gone through a similar situation with the number of shotgun gauges. There certainly weren't thousands or even hundreds of gauges, but you could have your choice of 4, 8, 10, 12, 14, 16, 20, 24, 28, or 32 gauge, plus the 410. There may have been others, but I can't find any record of them; nevertheless, this is enough to prove the point.

For this variety of gauges, there was an unbelievable number of load combinations — various sources mention 6000 or 7000. Ammunition factories around the world turned out thousands of load combinations, and a hunter or shooter could even have his own custom load manufactured for him. That takes me back to my reloading shop in the late '50s and early '60s. I would load any primer/powder/bullet combination the customer wanted so long as it fell within the recommended powder charges for that particular cartridge, and I certainly assembled some intriguing combinations.

Before getting involved with gauges, let's discuss the types of shotguns now on the market. Each has been around for a long time. There are just five types: single shot, bolt action, double barrel (side-by-side and over/under), pump action and autoloader. At the turn of the century, Winchester manufactured a few lever action shotguns, the Models 1887 and 1901. Despite the popularity of lever action rifles, this mechanism never became truly popular for shotguns. Scarcely 65,000 M87s were made, and only about 13,500 M1901s. The latter was made in 10-gauge only. I never shot a lever action shotgun, but have handled several.

Certain handguns now utilize shotgun-type loads. I do not think of these as true shotguns, even though some produce fair patterns at short ranges.

The single barrel dates back to the musket. It is the progenitor of the shotgun. The single barrel shotgun holds the distinction of being the "starting" gun for many new small game hunters. It's simple in design, usually having an external hammer. Move the operating lever or button and the gun breaks open, exposing the chamber. Drop in a loaded round, close the gun, and it's ready to shoot. Cock it by pulling the hammer back, and the single shot is ready for action. Simple and efficient, and in 20-gauge unquestionably the best shotgun for the beginner.

Most single shot outfits have an external hammer, but Savage's Model 220 was hammerless (which means it had an internal hammer) and incorporated a safety on the tang. Many years ago this particular model almost took me away from the double barrel I had used for several years. An elderly gentleman in a nearby village was supposed to be capable of firing a single shot outfit nearly as fast as the average hunter could use a pump. At my young age I found that hard to believe, but after I saw him kill a rabbit with the second shot from his single shot Savage 220, I became a believer. He was lightning fast. He carried a second shell in his left hand, with the front of the case facing him. When he flipped open the Savage single, the empty was ejected automatically and with unbelievable deftness he slapped the fresh round into the chamber and snapped the gun shut. He didn't bring the shotgun a foot below shoulder level. His speed was hard to believe, even while watching him demonstrate this remarkable feat.

A short time later I was using a borrowed Savage 220. I thought about the old hunter and decided I would give his method a try. I jumped a rabbit on top of a large mound of earth and promptly missed it with a hastily fired shot. At the bottom of the pile the rabbit cut hard to the left. I flipped open the single barrel, dropped in the live round, snapped the action shut, shoved the safety off and rolled the rabbit. As I stood high above my game, egotism filled my veins. What did the old hunter have over me? Why all the fuss? I had duplicated his feat with ease. Why would I ever have to carry a two-barrel outfit when I could use a single shot with such dexterity? I failed to take into consideration that my rabbit had graciously run in a wide circle, never getting more than 30 yards from me.

Twenty minutes later, my self-confidence was dashed when I tried to put a shell in the chamber head first. Believe me, it can't be done, although I tried hard enough. I decided my first try had been beginner's luck. On a third try, the rabbit was in the next township before I got the gun open. I stuck with the double barrel.

When we think of single shots, the inexpensive youngster's outfits usually come to mind. I recall when a good single shot hunting outfit could be

purchased for $10 or less. But that type of shotgun doesn't represent the single shot trap gun. Average starting price of these is well over $500, and you can go as high as you want. Single shot trap guns do not have safeties, incidentally. These outfits are used strictly for competition and, if a competitor inadvertently put the safety on in a match and failed to push it off, it would cost him a bird and maybe the match.

The configuration of a single shot trap gun is far different from a conventional hunting outfit. Most trap outfits have long barrels, 30, 32 or 34 inches being the norm. Stocks are designed to make the gun shoot high as trap claybirds rise quickly, and they almost invariably have a high ventilated rib. The single shot trap outfit is stocked too straight to make a good field gun, though some shooters occasionally use them for doves or pigeons. The trap gun is a far cry from the single barrel the old hunter used, but his battered Savage 220 performed to perfection when used for its intended purpose.

It would be unfair to close the chapter on the single shot without giving it credit for teaching countless small game hunters to hold their fire long enough to be sure of their shots. I started my small game hunting career with a 20-gauge double, and I know I fired my first shot dozens — yes, hundreds — of times when the rabbit or grouse was too close. In the back of my mind I always knew a second shot was available in case I missed, which was most of the time. I fired hastily many times just to beat whoever I was hunting with. I'm not proud of that, but it's the truth.

The single shot puts a different perspective on game shooting. For the vast majority — a few like the old veteran are the exceptions — one shot is all that will be fired from a single shot outfit at moving game. After tearing narrow furrows 20 or 30 feet in front of the gun, the hunter begins to realize he is firing too quickly. Since most single shot barrels are bored full choke, the hunter has to learn to hold his fire until the target is out where the pattern has opened up.

I once helped a veteran rabbit hunter, who used an old double but rarely fired the left barrel, poke a rabbit out of a log pile. We were about 20 yards from a creek, which ran along an old mine road. I managed to kick out the cottontail, which headed for the creek. I know the old hunter had a decent double barrel and was a dead shot, but thought he was having gun problems when the rabbit jumped the creek, raced up to the road, and was in about his tenth jump there before the old man fired. The rabbit did a high cartwheel and slid to a stop in the snow. I was flabbergasted. At that time I would have emptied my double before the rabbit hit the tram road. The old man must have seen the bewilderment on my face. He paused in the field-dressing

process long enough to tell me, "You have to let 'em get out a piece before you turn 'em over." That was good advice I have never forgotten.

With a single shot, patience is a virtue. To use the single shot successfully requires knowing the distance at which your barrel gives its best pattern. There should be no hurrying of the shot; there is just one, and that fact becomes impregnated in the single shot hunter's mind. That simple fact can make the single shot hunter deadly. True, the conventional single shot gun may have the dubious distinction of being the bottom rung on the shotgun ladder. Nevertheless, despite these seemingly insurmountable odds, the common single shot still stands shoulder to shoulder with its more impressive contemporaries in the everyday hunting world.

The two-barrel outfit dates back well into the 1800s. From a practical view, the double barrel should be the ideal hunting shotgun. A two-trigger model is actually two guns in one. There are two separate firing mechanisms or locks, two separate barrels which can use two separate loads, and two choke setups. It's unlikely that the hunter using a double barrel will ever have to quit hunting to get a spring or firing pin replaced. It's also unlikely that both units will fail at the same time. On rare occasions a double might double

A lineup of some of the shotguns I hunt with — autoloaders, an over/under, a couple of side-by-sides and a slide action. All work fine for certain applications.

— fire both barrels at the same time — but using just one shell will remedy that temporarily so you can go on hunting.

When I was in high school, I hunted one day with a young fellow who was carrying his grandfather's battered 12-gauge double. My companion was new to hunting, but told me he knew enough to hold his fire until the target was out where the pattern would be wider. That was sound advice from the grandfather, but it assured me I would get the first shot at anything that went out. He kicked out a rabbit, and I emptied my 20-gauge double in less than two seconds. The rabbit went another 10 yards before the boom of the old 12 split the air. The rabbit shifted into overdrive, and I waited for the second shot. When it didn't come, I looked at my hunting companion, who was rubbing his right shoulder.

"Why didn't you shoot again?"

"I tried. I pulled the back trigger as hard as I could but the gun wouldn't go off," he said dejectedly. "I'm not hunting any more with these blue shells. They kick like a mule."

It was no wonder he got belted; both barrels had gone off at the first pull. A little later the dog brought a cottontail our way, and the same thing happened except he got the rabbit. When I suggested using only one shell at a time, he said there would be no use in carrying a double barrel with just one shell. I was young and inexperienced, but I had sense enough to know that sooner or later that old 12 might come apart at the seams with two Peters high velocity loads going off at the same time. When lunchtime rolled around, I bid him farewell and headed home.

The double barrel is also a break-open outfit. As with the single shot, the double exposes the chambers when it is open, thus enabling the shooter to see through the barrels or see if the gun is loaded. When it is open, it cannot fire, and that's a safety point worth considering.

One drawback with many older doubles was the lack of ejectors. Instead of spring-loaded ejectors tossing one or both empties out of the gun, extractors just pulled the cases far enough out of the chamber for the shooter to remove them manually. That's a nuisance, and incorporating automatic ejectors that throw out the fired cases adds significant speed to reloading a two-barrel outfit. Ejectors function first as extractors, and then are timed to release and toss the fired case(s) out of the gun. Ejectors function only as extractors if the gun is not fired. They push the loaded rounds a quarter-inch or so out of the chamber so it's no problem to remove them.

I forgot earlier to mention it, but the farm lad's old double apparently had a broken extractor leg. He had to use his pocketknife to remove each empty. He was gifted with a rather strong vocabulary, and by noon time I was sore

from laughing at some of the comments with which he blessed the old double.

Anson and Deeley not only invented the hammerless shotgun, but also obtained a patent on the fore-end ejector system. Other designers came up with other ideas, and some ejectors boasted flat springs while others worked just as well with coil mainsprings. Trapshooters who reload often deactivate their automatic ejectors as they don't want to have to pick up the empty cases especially if they land in the snow or wet grass. I have used ejectors on hundreds of hunts and, unless you are interested in saving the empty cases, think they are next best thing to the wheel.

I'm old-fashioned and prefer two triggers on two-barrel outfits rather than a single trigger, even with a selector that lets you choose which barrel you want to fire first. I don't like the selector button incorporated into the trigger, but prefer it as part of the safety mechanism. My dislike of the selector on the trigger has nothing to do with its reliability; I just seem to forget which way to push the blooming thing for the barrel wanted. It's also comparatively slow to use. I guess using a two-trigger double barrel for decades makes it hard for me to adjust to a different method. With the two-trigger setup there is no uncertainly, and getting the choke wanted is merely a matter of choosing the front or back trigger. Theres nothing complicated about it and the triggers themselves are comparatively simple.

Still, with all the appreciation I have for the two-trigger setup, I have to admit a single trigger offers some distinct advantages. First and foremost, the single trigger gives the same stock length for both shots, whereas it varies an inch between them with the two-trigger setup. Basic stock length with a double trigger gun can be a compromise between them, which means it is not ideal for either, or it can be the length which will be proper for the front trigger — which fires the more open choked barrel and thus gets used most often in hunting — but therefore is a bit unsatisfactory for the rear trigger. An occasional gunner can fire either trigger of a two-trigger gun without releasing his grip or shifting his hand, but most probably slide the shooting hand a bit rearward to get onto the back trigger. That's one reason the typical two-trigger English game gun always had a straight grip.

A few gunners have always argued that the rear trigger should fire the open barrel, and there's a lot of logic to that approach as the recoil of the first shot drives the gun to the rear, in effect bringing the front trigger to the trigger finger. But so far as I know, all double trigger guns now in existence are set up to fire the open barrel with the front trigger, and I don't think there's a chance in the world that the system will change.

I have been fortunate in never accidentally setting off a double when

wearing heavy gloves, but I know it has happened. There isn't much space between the front trigger and the trigger guard, nor is there much space between the two triggers. The single trigger is in a class by itself here, and I must admit I like the wide open space between the trigger and the guard. This is a real advantage for quick shooting.

Some proponents of the two-trigger system claim this setup permits firing both barrels at once if desired, which, in turn, should enhance the chances of hitting. This might sound a little farfetched, but it has its followers. To me, it's ridiculous. The belief is that when both barrels are fired instantaneously, both a bigger and denser pattern will result. That's not the case. To begin with it's impossible to release both locks at the same instant. Even if this were possible, it's extremely unlikely both locks would work at the same speed. One is invariably faster than the other. That means the first shell will fire and recoil will begin before the second primer detonates, and thus the second shot charge will go somewhere above and probably to one side of the first. The only time I might consider trying a double shot charge would be at very close range at a dangerous big game animal. Even then it takes only a small fraction of a second to fire the second barrel normally, so from a common sense viewpoint, it's really wasting one shot.

There's another reason I don't recommend trying to shoot both barrels simultaneously. Breech-locking systems on doubles and over/unders can wear to a point where even one high velocity shell will make them open. When I was gunsmithing, I repaired more than one double that flew open with just one shot. Two shots firing at essentially the same time with such a gun could have been dangerous.

I recall one old double that would fly open occasionally. Its hinge pin was badly worn on one side. I didn't have time to make a new pin, so I turned the original one 180 degrees, and the gun was as tight as new. I don't suggest that this is a built-in answer for every double that flies open, but in this case it solved the problem at least temporarily. Installing a new hinge pin is not as easy as it sounds, incidentally. It can involve an awful lot of work. Send a high quality double barrel to the factory or a competent gunsmith for such repairs.

Other than custom outfits, and perhaps on some comparatively inexpensive shotguns, the two-trigger setup is riding off into the sunset. I'm not a strong supporter of the single trigger but, from a shooting standpoint in the field, have to admit a good single trigger is in a class by itself.

Most single triggers have a system for shifting the trigger action from one barrel to the other to choose which barrel will be fired first. A few doubles have non-selective-type single triggers; with such a setup, the shooter has no

choice in firing order. This is a good idea if both barrels are of the same choking, for it allows a simpler trigger design, but I can't figure out why this kind of trigger is installed on a two-barrel outfit which has different choke constrictions. There are times, such as on incoming doves, pigeons or even pheasants, when you want to fire the tight barrel first. That's impossible with a nonselective single trigger.

Firing two barrels with one trigger requires a complex mechanism. No single trigger that I've ever seen would be described as simple. Most hunters probably think it's just a matter of getting the firing mechanism shifted from one barrel to the other, but it's far more complicated than that. What they don't realize is that when anyone fires a gun he actually pulls the trigger twice. The first pull releases the firing mechanism, of course, and the second pull is involuntary; in fact the shooter can't tell he does it. It happens when the finger re-engages the trigger after it moves away during recoil. With most trigger designs this means nothing, but with a single trigger it results in an immediate second shot, whether desired or not and before aim can be adjusted, unless something blocks it. So all single triggers have some method of nullifying the involuntary pull. One common way is by use of an inertia block which momentarily remains in position during recoil and prevents the trigger from being moved twice despite the involuntary pressure applied to it. With such a mechanism, if the hammer is snapped on an empty chamber, it requires a hard thump on the butt pad to prepare the trigger to fire the second lock.

Early in this century, side-by-side doubles were very popular with all categories of smoothbore shooters, but as reliable pumps and autoloaders became available for a lot less money, these repeaters largely took over the shotgun market in this country. Nevertheless, there have always been shooters who recognized and admired the virtues of the double, and in the last few decades there has been a significant return to the double gun. However, for the most part, the first choice has been the over/under rather than the side-by-side. I've gone this way myself. I never thought I'd abandon the S/S, but for the most part I have. I like the thinness of the O/U's forearm, for one thing. True, it's deeper, but it feels better to me than the side-by-side's broad shallow design. The O/U also has what is called a single sighting plane; that is, the shooter is looking over just one barrel, usually topped with a rib, and this seems to give a more precise alignment with the target than the broad surface of a side-by-side.

A touchy point that can generate an argument is the claim that the under barrel produces less recoil, due to its more direct alignment with the shoulder. Since the bottom barrel normally has less choke than the top one, it

usually is fired first. This means it will be fired more often, but I have not been able to detect any significant differences in apparent recoil between the bottom barrel of an O/U and the right barrel of a side-by-side. So many variables are involved here that I feel it's next to impossible to prove. I will concede that an over/under doesn't seem to have as much barrel whip, which might make it a bit easier to get back on target for the second shot.

In competitive shooting, fewer heat waves rise from an over/under when the bottom barrel is used. This is of no real importance to the hunter, but a trapshooter running 100 birds will find the heat waves swirling over his barrel rib a real handicap.

Generally speaking, double guns utilize either of two firing mechanisms, the sidelock or the boxlock. The sidelock has its firing mechanisms, one for each barrel, fitted on the inner surfaces of flat plates which extend several inches from the rear of the action back along the left and right sides of the small of the stock. The locks or firing mechanisms of the boxlock are built inside of the action body. Most top grade English game guns are sidelocks, whereas most American doubles have been boxlocks. Some gunners claim there is a difference in strength, but it can't be significant. The sidelock design requires that less metal be removed from the action bar, which adds a bit of strength in that area but necessitates taking more wood from the stock at its weakest point. The boxlock has a stronger wood-metal joint, but its design puts the cross pin which supports the internal hammer near the angle of the action face and bar, its weakest point. Truth is, these criticisms are not highly significant, as has been proved by the use of both types of guns over several generations. Ultimately, the big advantage of the sidelock is the large flat metal area which each sideplate provides for the engraver to display his ability. In other words, the sidelock has snob appeal. So much so that it's not unknown for boxlock manufacturers to build guns with fake sideplates just to have space for engraving.

My late brother Dan's 16-gauge Crescent was actually a bar lock action with sideplates. In that particular shotgun, the bar lock consisted of only three working parts. The bar lock is a direct descendant of the muzzleloading era. In the bar lock, the mainspring drives the hammer. The mainspring is placed forward of the tumbler and hammer, so that it and the lockplate extend alongside or under the barrel. It's possible the name derived from the fact that the extension of the lockplate, which supports the mainspring, looks like a bar.

Sideplates are often quickly detachable, to allow easy access to the locks themselves for cleaning.

The boxlock also originated in the black powder gun. On old doubles, all

the parts except the hammers are situated inside the lockplate. The hammers stick up through slots in the stock. In the modern shotgun, everything is enclosed and very compact. There is no need to cut a lot of wood out of the area ahead of the grip section.

The boxlock design is not used on double barrels only. The modern single shot outfit incorporates the boxlock. Most of us are familiar with the single shot's hammer protruding through the top of the frame. The boxlock can also be used in a single shot hammerless version.

For securing the double's barrels to the breech or action, a number of designs have evolved over the years. They all start by hooking the barrels onto a hinge pin at the front of the "bar" forming the front bottom section of the action. The rear of the barrels is rotated upward to expose the chambers for loading, then downward to lock against the bar for shooting. The bottom of each barrel is flattened at the rear to fit tightly against the top surface of the bar (sometimes called the water table). With such a large interfacing area to work with, it was only logical to try securing the barrels and action together here. This was done by extending a pair of projections or "lumps" from the bottom of the barrels through recesses machined in the top surface of the bar. The rear edge of each lump is indented near the top to form a locking surface for an action bolt which is moved backward and forward in grooves when the operating lever is functioned. This system was developed by the famed gunmaker James Purdey in the 1860s, and is often called the Purdey double underbolt. It is simple and strong and takes up little space.

However, there was a question of whether the underbolting was, in itself, strong enough to withstand the years of shooting to which a gun might be subjected, particularly a lightweight gun as favored by the British. Tests proved that when a shell was fired in a hinge-action double, the rearward pressure exerted against the vertical face of the standing breech had a tendency to separate the barrels from the breech by slightly flexing the bar of the action downward. This bending could most easily be neutralized by adding to the rear of the barrels a metal extension which fitted into a recess in the top surface of the action body.

Numerous versions of this extension evolved over the years, including the famous Greener cross bolt (W. W. Greener was a noted gun builder and gunwriter in the late 1800s); the doll's head, which was essentially an enlarged disc of steel on the end of a narrow necklike projection; and the American rotary bolt. Greener's design consists of a cylindrical bolt that is moved through a transverse hole by the operating lever and locks the barrels and standing breech together. When properly fitted (as Greener's always

were, though that was not the case when some other gunmakers used this design after the patents ran out) this was an exceedingly strong locking method.

There are other systems. For example, the popular SKB over-unders also utilize a transverse sliding bar which secures two deep metal extensions on the rear end of the barrels after they drop into recesses in the top of the receiver. This is essentially the same as the Kersten locking design developed in Europe. When the top lever is activated, it moves slots in the transverse bar into alignment with the slots in the receiver, and this allows the barrels to be opened or closed. When the gun is closed, a small protruding pin, called the locking piece retainer, is depressed by the top barrel, and the transverse bar, which is spring-loaded, slides back through the slots in the barrel extensions and also brings the top lever back to center on the tang. This is a strong and efficient design, although, as with all top extension systems, it clutters up the rear of the barrels and thus interferes somewhat with the loading process. Where the shooting is fast and furious (which doesn't happen nearly often enough for most of us), such a lockup can be a nuisance, but in most hunting situations this aspect is unimportant.

Another system that comes to mind is a top lock first used on Remington's M32 over/under. This is a sort of shield which from the end looks like an upside down U that moves forward and backward on rails when the operating lever is functioned. When the barrels are closed, the front end of the shield overlaps the rear end of the top barrel, securely locking it to the standing breech. This design was used later on the Krieghoff, the Finnish Valmet, and the Valmet-built Savage M330. It's an interesting and strong unit that was picked up again by Remington with their sophisticated M3200.

Ruger's Red Label over/under employs two round rods with flat bottoms that fit over lugs protruding from the top of the bottom barrel. When the operating lever is pushed to the right, the double rod system is pulled back into the receiver and the barrels are free to open. Similar to the SKB's locking piece retainer, the top barrel on the Ruger depresses a plunger that allows the locking plungers to slide over the flat-topped lugs on the bottom barrel.

The doll's head received all types of accolades in earlier years but isn't seen often on today's guns because it has to be hand-fitted, and that kind of gun making doesn't fit well into today's mass production methods. Some doll heads incorporated a cross bolt design, and this made for a very strong bolt up.

Another version, which I call the rotary bolt lockup, is a sloping angle of metal on the bottom of the operating lever that slides into an extended rib protruding from between the rear of the barrels. The extension has a slot cut

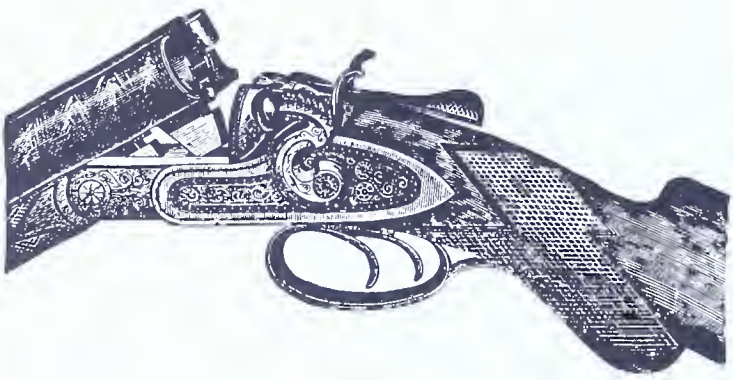
into it. The bottom of the slot is angled upward. When the gun is closed, the spring-loaded top lever (rotary bolt) swings back to center, and the angled finger on the operating lever rotates into the angled slot, pushing downward on the barrels. On some shotguns such as the Savage Fox Model B, the degree of angle in the slot is rather steep. The angle is important because it keeps a constant downward pressure on the barrels. This is a tight lockup, but problems will develop if the extension's angle or the rotary bolt's angle wears. Sometimes honing will help but, if parts are available, a new rotary system should be installed.

I have barely scratched the surface on the subject of two-barrel bolting systems. The basic purpose of any such system is to keep the barrels locked to the frame during firing. Trap and skeet shooters might wear out bolting systems, but the hunter has little to worry about. Generally an occasional good cleaning is all that is needed to keep a field gun functioning properly. Go easy on oil and grease on the locking surfaces; metal to metal contact will provide a tighter fitting of the locking parts.

Before leaving double outfits, I might as well mention safeties. There are basically two types: automatic and non-automatic. The automatic design returns to the safe position when the top lever is moved to the right to open the gun. The non-automatic type must be manually retracted after reloading. Personally, I prefer the automatic. In the golden years of waterfowling, the non-automatic was in vogue. When birds were coming in at all angles, market hunters just kept shooting and loading and shooting; they didn't want to mess around with a safety every time the shotgun was reloaded. If a two-barrel shotgun was not equipped with a non-automatic safety, the hunter would remove the connecting link and perhaps the safety slide on the tang.

Using a double with the safety on "fire" or with the link disconnected is actually hunting with the hammers cocked and nothing to prevent them from falling if the shotgun is dropped or jarred. It's foolhardy. There's no need for non-automatic safeties on small game or waterfowl hunting guns today. I subconsciously push the safety slide while bringing the gun to my shoulder. It takes but a fraction of a second. My SKB Model 600 has a non-automatic safety, and I'm constantly checking it to make certain it is on "safe."

The safety is not a guarantee that the gun won't fire. Most shotgun safeties lock only the triggers, and the sears can still come loose from a hard jar. This is one reason it's not a good idea to slam a double or over/under shut. I have seen hunters reload a single or two-barrel outfit and then snap the small of the stock down quickly to flip the gun shut. That is asking for trouble with a capital T. Never snap a gun shut. Grasp the gun at the forearm



Early Greener S/S had an extension rib and rebounding hammers, choke-bored barrels.

and pistol grip and, with the barrels pointed in a safe direction, close it with an even gentle movement. Keep in mind that the sear for each trigger is engaged in a notch. If the notch is shallow, the sear might jump out when the gun is bumped or jarred. To prevent a discharge from this, some have what is called an "intercepting safety." It keeps the internal hammer from hitting the striker unless it has been released by the trigger. The intercepting safety is old. Greener claims it dates back to the late 1700s.

Pumps and autoloaders normally have a cross-bolt type of safety in the front or rear of the trigger guard. (Mossberg's Model 500 pump and Model 712 autoloader are two I can think of that have the thumb-type safety on the tang.) A cross-bolt safety on the trigger guard blocks only the trigger.

The best safety measure is to treat all guns as if they were loaded. That's rule number one. Number two is to keep the muzzle pointed in a safe direction at all times, and especially when loading or unloading. No safety is a hundred percent safe. Anything can happen. Common sense is a better safety than any mechanical device ever invented.

The pump or slide action shotgun has a long history. Sam Colt invented a 6-shot cylinder-type shotgun in 1839. A few years after Colt's invention, Roper's 4-shot repeater made its debut, using reloadable steel cases. These are two early repeaters that we know about. It's fair to say there were many others. The Spencer Repeating Arms Co. started building pump shotguns in the late 1800s. A little later the Burgess slide action arrived. It used the pistol grip as an actuator. Both the Spencer and Burgess models were short-lived. Winchester's Model 93 proved the slide action was here to stay. It was followed by the famous Model 97. Many older slide action fans mourn the loss of the visible hammer that helped give the Model 97 its distinctive looks.

Shortly after 1900, John Browning, who had invented a lever action shotgun which Winchester introduced in 1887, invented a slide action hammerless for Stevens. In the middle of World War I, Remington's Model 17, which was a dressed up model of the older Stevens, made its debut.

Modern O/U, the Ruger Red Label in 12-gauge, has single trigger and covenient selector.

Remington also had their Model 10 on the market. Its most interesting feature was bottom loading and ejection, the same as the later Remington Model 17 had. Ithaca's old Model 37 and new Model 87 have this desirable feature.

I'm not a slide action fan but it has always intrigued me that the side ejection system would still be more common in pump shotguns than bottom ejection. If the bottom system were far more complicated to build and more prone to failure, I would think differently, but it has worked to perfection in the Ithaca pumps for generations and also in Remington's Models 17 and 29. The new Browning BPS also has bottom loading and ejection.

My brother Cull owned a 12-gauge Remington Model 31 slide action. Shooting from the left side, the whizzing of empty cases past his face annoyed him. In fact, he would lower the shotgun, work the slide and re-shoulder the outfit to fire a second shot. He was adept at operating it at shoulder level, but the right side ejection bothered him. He would have been much better off with Remington's Mode 29. It was discontinued in 1933 and he purchased the Model 31 in 1934, but a few 29s were still lingering on store shelves when he picked the more expensive Model 31.

The Winchester Model 97 pump held the spotlight for many years. Marlin's Model 1898 had a visible hammer much like the 97's. Around 1906, Marlin brought out their Model 17 hammerless (not to be confused with the Remington Model 17) but, a quick glance could confuse it with the Winchester 97. One obvious difference was that the Marlin had a straight stock, while the Winchester had a pistol grip. Marlin introduced a number of models during the early 1900s. An excellent D-grade Marlin Model 24 will bring close to $1000 nowadays. Savage got into the pump shotgun act in the 1920s, with their Model 28A. It must have had a strong following for it was still being manufactured in 1940.

These few paragraphs are by no means intended to cover the entire family tree of the slide action shotgun. They touch on only a few well known outfits.

The quest for repeating guns dates back to the days of the *ribauldequins* in the 1300s. With those, a number of parallel barrels were locked together in a unit. The gunner simply passed a flame across the touchholes on top of the barrels, setting each one off in order. Accuracy couldn't have been impressive and the barrels had to be loaded separately. However, this was the first attempt to make an anti-personnel weapon. The idea for a repeating firearm was born long before Sam Colt designed his 6-shot revolving-cylinder outfit.

There is disagreement on whether the pump shotgun (some call them slide or trombone actions) was invented before the pump action rifle. If the experts aren't sure, I'm certainly in no position to give a viable answer. The fact remains that we have both today, and both are reliable and dependable. Which one came first is immaterial.

Most pump shotguns work on the same principle. Shells are loaded through an opening in the bottom of the action into a tubular magazine beneath the barrel, compressing a powerful spring in the process. A shell latch or lock catches the rim of the last shell inserted, thus holding it and all of those previously loaded. When the slide is pulled back to open the action, the lock is depressed and the rearmost shell in the magazine is pushed by the spring into a lifting device (carrier or elevator) which has dropped down to receive it. When the slide is shoved forward, the carrier brings the shell up into alignment with the chamber, the bolt pushes it home, and the spring-loaded carrier drops down to receive the next shell from the magazine. After the shell in the chamber is fired, the slide is pulled back and an extractor pulls the empty case out of the chamber. Almost at the end of the bolt's rearward movement, the empty case comes into contact with an ejector, which tosses it out of a port in the side of the action. While all this is happening, the shell lock is released and a fresh round is shoved into the carrier, to be chambered when the slide moves forward.

Some pump guns eject their empties out of the bottom opening through which they are loaded, instead of a side port. The M37 Ithaca is the best known of these, as it was around for generations before being replaced recently by the M87. Browning's BPS also has bottom feeding and ejection, and there have been other guns with this feature. This requires a somewhat different mechanism. In the M37, for example, the carrier is two fingers that rest against the top of the action while a shell is in the chamber. When the slide is pulled back, two extractors pull the empty case from the chamber. Just before the bolt assembly reaches the end of its travel in the action, the carrier fingers are forced downward, throwing the empty case out of the bottom port. At that same instant, the two shell stops are released, allowing a

fresh round to come out of the spring-loaded magazine tube. When the slide is moved forward, the carrier positions the loaded round in front of the chamber and the bolt assembly shoves it in.

I am not going to attempt to explain all the variations of the loading and unloading mechanisms of every pump shotgun. They were my nemesis when I was gunsmithing. I always found it hard to believe that an old pump shotgun could look as healthy inside as many of them did, and still fail to function. The timing in a pump shotgun is just as critical as the timing in a high performance car's engine. Everything must work in the correct sequence and with split second timing, from the carrier dropping in front of the shell in the magazine tube to the hammer cocking as the bolt assembly moves backward. In that flashing backward and forward stroke of the slide, numerous operations must take place in perfect order. If the pin holes in any of the moving parts were elongated or the pins were bent or worn, those old-timers would malfunction. But the most frustrating thing was, they didn't fail every time. A half-dozen test rounds could be fired without the slightest problem, then something would go awry. New parts were out of the question. Even old parts from similar models, if you were lucky enough to have a spare for parts, seldom cured the problem, as they were also worn from use. And fabricating new parts was economically out of the question. Sometimes the only solution was to retire the family heirloom and buy another shotgun.

To have the repeating benefits of the slide action shotgun, compactness must be sacrificed. Unlike the double barrel which has most of its working parts closely integrated, the pump gun needs a long receiver to accommodate the sliding breech mechanism. There also has to be room for loading and unloading inside the receiver. This makes the slide action outfit longer. The long magazine tube underneath the barrel will hold four shells on most pumps, but must be plugged to hold only two when used for migratory game and, in some states, for upland game. It might not be significant, but as the shells are fed from the magazine into the chamber, the gun changes balance. A hunter will never notice it, but it happens just the same. These disadvantages, as some refer to them, never have been drawbacks to the pump's popularity. It, along with the autoloader, almost drove the side-by-side doubles into oblivion some decades ago.

When we think of firing speed in shotguns, it's only natural to think the autoloader will hold the spotlight. That's doubtless true with gas-operated models. However, a top-notch slide action shooter can come close to matching the speed of the older long-recoil autoloaders in a three-shot firing match. I'm not going to say the autoloader will lose, but I will say it won't be any walk-away contest for the self-operating shotgun.

When I was still in grade school, I spent Saturdays in small game season dogging for any hunter who would put up with my constant barrage of questions. A veteran pump gunner occasionally hunted on a farm adjoining our land. When I saw him in the next field one day, I made some excuse to get in on the hunt. I had heard of this fellow's lightning speed working a slide. Comments such as "faster than a double barrel" or "two empties in the air at the same time" or "first shot killed the rabbit, but he couldn't stop until the gun was empty" were common when his name came up in a hunting discussion at the local store. It was claimed he used a dozen or more boxes of shells in a season.

Even at the tender age of 10, I was a two-barrel supporter. I was convinced no one could pump shells through a shotgun faster than my brother Dan could slap the triggers on his Crescent 16-gauge double. But life is a hard teacher. My boyhood admiration for my brother's ability with his double went down the drain when I bounced a rabbit out of a brushpile for the pump gun shooter. It has been well over fifty years now, and time has undoubtedly embellished my memories about the slide action hunter, but looking back I am still impressed. I am not sure which of his shots rolled the rabbit. I do recall that I picked up three empties. That single episode almost swung me to the pump. I went to sleep night after night fantasizing about the skills of that pump gun shooter. I was determined to emulate him. The only thing that worried me was where I would get enough money for shells. The autoloading shotgun was illegal for hunting back then in Pennsylvania, but that fellow wouldn't have needed one anyway. He was as close to the autoloader as a human can get.

The autoloader or semi-automatic is really a modified version of the pump gun, one that is recoil or gas operated. The slide has been removed and the mechanism is activated by forces derived from the fired shell.

The semi eliminates the manual work required by a slide action. John Browning came up with the idea of a self-operating shotgun in 1900. It caused little stir in this country, so Browning took it to Belgium where Fabrique Nationale (FN) put it into production.

The simple pull of the trigger on an autoloader sets the entire working mechanism into action. The sear is released, the hammer falls against the firing pin and sets off the shell in the chamber and, in most of today's autoloaders, some of the gas behind the shot charge is vented through a small hole in the bottom of the barrel into a chamber. Inside the chamber, this gas compresses a piston which drives the breech mechanism backward against a strong spring. During this operation, the fired case is ejected and the shell retainer in the magazine is moved aside to allow a fresh round to slide onto

the carrier. The heavy operating spring then shoves the bolt forward. It picks up the new shell and shoves it completely into the chamber, allowing the bolt to lock at the last instant.

Each manufacturer has his own design of power piston, but all must be kept relatively clean to function flawlessly. The shotgun's instruction manual explains this operation in detail. It's wise to clean the gas port and piston occasionally during the course of a hunting season.

On autoloaders such as the older Browning models, recoil shoved the bolt mechanism backward against the heavy operating spring, ejecting the empty and cocking the hammer. The spring then supplied the force to shove a new round into the chamber on its return trip. Long-recoil types have some tendency to jam. The main reason for this (I have actually witnessed this) is the "soft" or "light" shoulder. The butt pad must be held firmly against the shoulder for the gun to operate smoothly. This can also happen with light loads in gas-operated autoloaders. I have demonstrated this by shooting a light field load from a gas-operated semi held in my hands rather than tightly against the shoulder.

There is supposed to be considerably less recoil from autoloaders than from other types of action. That's not true. The same shotshell load in all guns of the same gauge and weight will produce the same amount of backward thrust. With the autoloader, however, the recoil is spread over a longer period of time. Hence, the shooter is not subjected to as abrupt a jar. The gas operated outfit requires more preventive maintenance, and that's a prime point to remember.

Many of today's hunters, especially waterfowlers, like the autoloader. Small game hunters seldom have need of the third shot, but incoming ducks and geese offer many opportunities to use the third round.

Many old autoloaders were heavy, but some of the new models are unbelievably light. For instance, Remington offers the Model 1100 LT youth gun which has a short stock and barrel and weighs only 6½ pounds. I have a Remington 1100 Lightweight 20-gauge that barely hits 6¾ pounds. There are other lightweight makes and models, but I'm familiar with the two Remingtons.

I'm sure the autoloader will enjoy a long period of popularity. At this writing, Remington is getting ready to introduce their new 10-gauge autoloader. The action is machined almost entirely by robots, which means computerized tolerances. This new 10-gauge semi reflects the ultimate in design and strength. Today's autoloaders are dependable. Even on the trap and skeet fields, where guns take a pounding, there are few problems.

I never write about autoloading shotguns without saying that this type of

shotgun is definitely not for the beginning hunter. The autoloader reloads instantly and is in a sense always ready to fire. In the excitement of the hunt, an autoloader can be accidentally discharged if a beginner forgets that. I believe a young hunter should have just one shot. That makes the old single shot an ideal outfit for the first couple of seasons. Don't think you're doing your son a favor by presenting him with a semi for his first hunting shotgun. Let him get some experience first. After several seasons with the single shot, the new hunter will know what type of action he wants. That's the time to buy a repeater.

I won't use much space describing bolt action shotguns. While they are functional and can give years of service, they are slow to operate. There's no comparison between a bolt action rifle and a bolt action shotgun. I will concede they make ideal beginning outfits in the repeater line. The new hunter has to lower the bolt action to operate it smoothly, and this cuts down on the chances for a shooting accident. Marlin offers several 10- and 12-gauge bolt action waterfowl shotguns for hunters who want an inexpensive goose outfit.

Someone is sure to note that I have overlooked the discontinued Ithaca Model 66 "Supersingle," which was available in 410 bore and 20-gauge. Basically, the Model 66 was designed for the young hunter. It had some nice safety features. For instance, the hammer had to be fully cocked for the shotgun to fire. It would not fire if the hammer slipped out from under the thumb. The hammer was not cocked by the opening lever but had to be pulled back manually. It's off the market now, but it is still the beginner's shotgun in my book.

Basically, I have told how various shotgun actions operate. My coverage is not meant to be a complete breakdown on the entire operating mechanism of each style of action. But I think it's plain to see that the shotgun has come a long way from the pioneer's simple musket to the Remington 10-gauge autoloader.

Shotgun Gauges

MOST SHOOTERS ARE familiar with rifle bore measurements. We know that the distance from the top of one land to the top of the opposite land, in a rifle bore, indicates the caliber. In a 30 caliber, for instance, this measurement is .300. This is called the barrel's bore diameter. The grooves are cut or swaged into this, and usually are .004 deep, which makes total groove measurement (to the bottoms of opposite grooves) .308. That's why bullets commonly called 30 calibers actually measure .308 inches.

The bore diameter in a shotgun normally is referred to as its gauge. Currently there are only five shotgun gauges. In descending diameter they are: 10, 12, 16, 20 and 28. The 410 is not a gauge; actually, it's a bore measurement or caliber — .410. Gauge diameter is determined by the number of bore-size lead balls it takes to make a pound. If 12 identical balls weight a pound, a shotgun bore which will just accept one of these balls is defined as a 12-gauge. A bore which will accept a 16-to-the-pound ball is a 16-gauge, and so on. This explains why, in gauges, the smaller the number, the larger the diameter. This system is not true in regard to the 410. It takes approximately 67 .410 lead balls to make a pound, not 410. In a practical sense though, the 410 has to be included in the shotgun lineup, so it brings the total number of "gauges" to six.

I have mentioned that in the gaslight era there were numerous gauges, and the number gradually dwindled to the half-dozen mentioned. Apparently, these will be with us for the foreseeable future. The 410 was born after the turn of the century and there hasn't been another introduction since then. The 410 is not my idea of a hunting shell, but skeet shooting assures it of continued production. The 28-gauge is being hard pressed to stay alive, which is disheartening to me as it makes a good upland gauge in a light gun.

The 10-gauge is the largest shotshell now made in America, but overseas both 4 and 8-gauge shells were available long after World War II, and still may be. Early in this century both of these large bores enjoyed some popularity among waterfowl hunters in the U.S. The advent of smokeless powder and choke constriction made the 10- and 12-gauges, which were lighter and had much less recoil, about as effective as the two huge shotshells. I'm not certain how long 4- and 8-gauge shells were around, but a 1903 A. J. Rummel Arms Co. catalog lists brass shells for a variety of gauges, including the 4- and 8-gauges.

The 4-gauge was a monster. Some black powder loads ran as high as 10 drams of powder behind a full 3 ounces of shot. The 8-gauge used "only" 7 drams of black powder and 2 ounces of shot.

The 3½-inch 10-gauge Magnum is a welcomed newcomer to hit the scene during the last twenty years. Long range shooters appreciate its large shot charges — up to 2¼ ounces of lead or 1¾ ounces of steel. This large load of lead shot actually is greater than the 8-gauge offered. It took 7 drams of black powder (there are 16 drams in one ounce) to handle the 2-ounce shot charge in the .835 bore of the 8-gauge. Smokeless powder allows 8-gauge offerings in the 3½-inch 10-gauge Magnum, which has a bore diameter of .775.

Shotguns chambered for the 10-gauge were made in this country prior to World War II and in Europe after that. United States got back into the act when Ithaca's master gun designer Jim Tollinger put together a 3½-inch 10-gauge autoloader around 1974. Tollinger built his first 10-gauge by hand. He told me he drew the parts to scale and had Ithaca's machinists mill them out of raw steel. He then refined them until he had a functional autoloading shotgun. The 10-gauge he used when I hunted geese with him was the original gun he designed and made. It was a real honor for me to handle a shotgun that had literally been made by hand. Not very many people have the gun-designing skills of Jim Tollinger.

Ithaca went through some reorganization changes, and the 10 Mag was dropped from production. Remington recently entered the picture with computerized production for their version of this autoloading 10-gauge Magnum. Their method is called Flexible Manufacturing System (FMS). Generally speaking, FMS is a grouping of computer-controlled, semi-independent work stations linked by an automated handling system.

At a gunwriter's seminar at the Remington plant in Ilion, New York, production of a vastly improved 10-gauge Magnum autoloader was announced. The waterfowler will benefit from the big 10's ability to handle large loads of steel shot. The expanding requirements for use of steel shot in

Standard Bore Diameters

10 gauge	12 gauge	16 gauge	20 gauge	28 gauge	410 bore
.775 inch	.730 inch	.670 inch	.615 inch	.550 inch	.410 inch

the marshes and flyways across America have created a genuine need for the 10-gauge Magnum.

The 12-gauge, with a bore diameter of .730, is unquestionably the most popular gauge in the United States and England. Handloaders can do a lot of things with the 12. The can literally duplicate the loads of any of the smaller gauges, though I don't know why hunters would want to.

The basic reason for using a 12-gauge is to take advantage of its large shot capacity. I see no point in using a 12 to duplicate light 16-gauge loads or loads of the 2¾-inch 20-gauge. Pushing the 12-gauge's shot charge to compete with the 10-gauge seems more logical. Federal, Remington and Winchester offer 1½-ounce loads in the 2¾-inch hull and 1⅝ and 1⅞-ounces in the 3-inch Magnum. All of these loads are available with BBs, 2s, 4s and 6s, and Remington offers Duplex Premium loads combining several shot sizes in both shell lengths. With these heavier shot charges available in the 3-inch 12-gauge, it's pretty obvious the waterfowler with a 12 is not too far behind the mighty 3½-inch 10-gauge's 2¼-ounce loads.

In an interesting development growing out of the legal necessity to use steel shot for waterfowl shooting in many regions, in late 1988 Federal Cartridge Co. announced the availability of 3½-inch 12-gauge shells. The increased length permits use of 1⅜ ounces of steel shot at a velocity of 1300 fps. Shot size is F, T, BB and number 2, at this writing. It would not surprise me if various sizes of lead pellets were made available before long, as they would have logical application for turkey hunters. Mossberg was the first manufacturer to chamber a gun for the stretched 12, the Model 835, which is a variation of their popular M500 slide action. The M835 has a 28-inch vent rib barrel which accepts Mossberg's Accu-Mag choke tubes and thus makes it suitable for various types of waterfowling. Another gun which will probably be chambered for the 3½-inch 12-gauge is Browning's BPS, which is currently manufactured for the 3½-inch 10-gauge so should be easily adaptable. Mossberg's M835 reportedly will handle conventional length 12-

gauge shells as well as the 3½-inchers, which should interest many hunters.

Federal also recently announced Triplex loadings in some of their shotshells — pellets of three sizes in the same shell. As with the Remington Duplex loads, these doubtless are intended for very specialized uses.

Unquestionably, the 12-gauge is by far the most popular gauge at the moment. In fact, it probably always had the edge. Some of its popularity stems from a misconception that the 12-gauge shoots significantly harder than the smaller gauges. From a velocity standpoint, it doesn't, but if you think this belief is not impregnated in many 12-gauge fans, ask them about it. Several relatives of mine get incensed each time I make this statement. One even asked me how I could be so downright stupid. He indignantly proclaimed that the 12-gauge shot faster, hit harder and killed quicker than any 16 or 20, including (a lot of emphasis on "including") the blasted pea-shooting 3-inch 20-gauge. This adoration gives some idea how strongly many hunters feel about their big 12-gauges. I'll get back to this subject in the shotgun patterning chapter.

The 16-gauge, to my way of thinking, is unbeatable in the uplands. It's a genuine compromise between the 3-inch 20 and the 2¾-inch 12-gauge. I may be partial to the 16 because my brother Dan had such great success with his Crescent 16-gauge double for over thirty years. Although Dan was never in good health, and was short of breath constantly, he shot more rabbits, grouse and squirrels than any of the fellows he hunted with.

I recall him winning a small bet based on shooting at some dismantled car doors. The morning's hunt was over, and during the lunch break an argument started on how hard different gauges shoot. A 12-gauge buff argued loud and strong that a 12-gauge high velocity shell shot harder than a 16-gauge high velocity shell. He went so far as to claim his Davis 28-inch full choke would put three times as many pellets through the car door as the 28-inch full choke on Dan's 16-gauge Crescent double. Dan disagreed. Number 4 shot high brass shells were available for both gauges, so the rusty car doors were set up about 30 yards from the shooting line.

The 12-gauge fan took careful aim and fired. As the automatic ejector on his Davis sent the empty sailing into the crowd, he turned to Dan and said something like, "Count 'em and weep." He was referring to the holes in the door.

Dan dropped a high brass load into his full choke barrel and smacked the other door. Everyone surged forward to see the damage. Most of the bets were on the big 12, but a hush fell over the crowd while the doors were examined, and Dan shortly was declared the winner. I don't remember all the details after fifty years, although Dan and I often recalled this episode, but

the 12-gauge certainly didn't put three times as many holes in the door as Dan's 16-gauge.

I have no idea why the 16's popularity has plummeted so low. Perhaps it's because the 16 isn't on par with the 12's shell selection, and with the 3-inch 20-gauge being capable of duplicating some 16-gauge loads, it's caught between a rock and a hard place. For some years, few if any 16-gauge guns were manufactured in the U.S. Ammunition continued to be made, of course, as countless 16s were in use throughout the country, though I have the feeling load selection was not as wide as for the 12 and 20-gauges. However, Browning recently reintroduced their Sweet Sixteen autoloader and their Citori model over/under in 16-gauge.

The 16 has always been popular in Europe — more so on the Continent than in England, though it's available there too, from Churchill and Parker-Hale, for example, in side-by-side models. On the Continent, Merkel makes both over/unders and side-by-sides in 16, and the latter design is also available from Arizaga, Bernardelli, Francotte, Garbi, Piotti and doubtless others.

The 16-gauge has a nostalgic past and was one of America's favorite hunting shells in time gone by. I'd like to see more guns become available in this gauge, as in many ways it's the ideal size for upland hunting. If made on a true 16-gauge frame, a gun could be almost as light as a 20, and handle ammo as effective as the lighter 12-gauge loads. But somehow I don't expect this to happen.

I have to be careful when writing about the 20-gauge. I started my hunting career with a Stevens 20-gauge double and have used the 20 for over fifty years, so it's hard to hide my affection for this shotshell.

It was probably 1937 when I bought my Stevens double 20-gauge. To be downright honest, I wanted 16-gauge double like Dan's, but I was recoil shy, with a capital "S." I had fired both Cull's 12 and Dan's 16, but both scared me half to death. I was afraid of the large shells. When a mail order catalog ran a special on Stevens 20-gauge doubles, Dan suggested it was the perfect shotgun for me. I had a total of $8 at that moment in time. That would have bought a single shot outfit, but the double barrel — and I really wanted a double outfit — was $19.95 plus shipping. One of my married brothers had an account with the firm, and I got the 20-gauge and two boxes of shells, along with a lecture on paying off the balance from my six-dollar-a-month student job of sweeping the gym and auditorium floors twice a week at high school. I never missed one of the five three-dollar-a-month payments. I still have the old Stevens, too.

For a long time the 2¾-inch 20-gauge, with its ¾- or ⅞-ounce shot

charge, was considered a close range outfit. Much like the smaller 28-gauge, the 20 was often called a "quail" shell. When I proudly carried my new 20-gauge into the country store, the early evening loafers stared in disbelief. Several veterans cut me to the bone, and the elderly lady who owned the store warned me that she stocked only 16- and 12-gauge shells. My visit was short, as you can imagine, and I became more bitter every step of the way home through the darkness. I was tormented by thoughts of being fool enough to buy a 20-gauge, and I was sure the shiny Stevens would make me the laughingstock of the community.

But it didn't. Instead, the 20-gauge shell and I formed a friendship that has lasted for decades. I've hunted a good many places with the shotgun, and I've hunted with and tested all other available gauges. I've had considerable experience with the larger shot charges of the mighty 12, but I rarely felt I needed its extra pellets. Most of my rabbit and grouse shooting is at ranges under 35 yards, so the 20-gauge double, with 8s in the open choke barrel and either 7½s or 6s in the choked barrel, produces patterns that will handle everything from quail to rabbits. From a gunwriting standpoint, I've been severely castigated for sticking with the 20-gauge and extolling its virtues, but I always come right back and say that if I thought a larger shell would be more productive for general small game hunting, I would have switched long ago.

Despite all the confidence I have in the 2¾- and 3-inch 20-gauge shells, I wouldn't suggest either to the long range waterfowl hunter, and I would have serious reservations about using a 20 for turkey and some pheasant hunting. The heavier shot charges of the bigger gauges will give denser patterns at long ranges. If I ever hunt pheasants in the Dakotas, I will be carrying the 12-gauge over/under bored modified and full.

I believe the 2¾-inch 20-gauge shell is at its best with shot charges of 1 ounce or less. I have loaded it with 1⅛-ounces of shot, but that's pushing the short case to the limit. There are roughly 350 pellets in a 1-ounce load of 7½ shot. Another 44 pellets may not seem enough to be significant, but everything in a shotshell load must be balanced to be efficient. I see no need for stretching the potential of the 2¾-inch case with a 1⅛-ounce load when the 3-inch 20 hull handles it more efficiently, along with the 1¼-ounce charge that supposedly is the epitome of efficiency in the 12-gauge. I have to be careful in making these statements as I don't want to give the impression the 2¾-inch case can't handle 1⅛ ounces of shot, but I just think such heavier loads are more at home in the 3-inch hull.

When the 8-gauge was outlawed (the 10-gauge is the largest now allowed in this country), the 10 quickly took the lead. But its longevity was short-

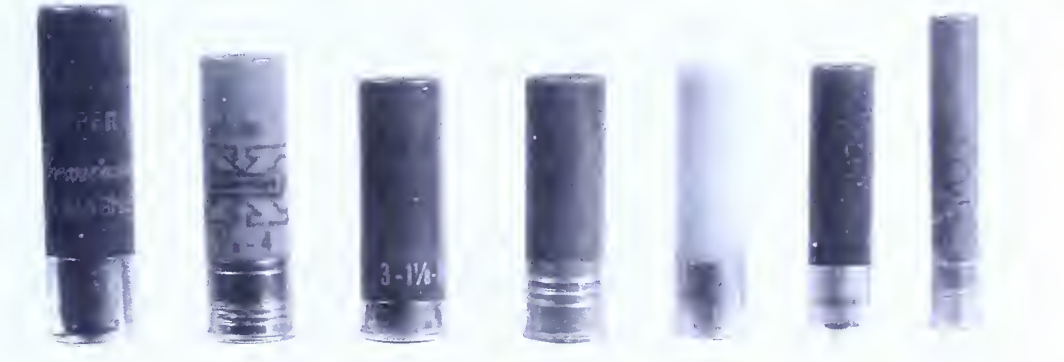
lived here. The reason, I think, as mentioned earlier, was the advent of smokeless powder, which allowed the 12-gauge to nearly duplicate the 10's performance and with less recoil.

While proponents of the 12-gauge claim the 20 will never equal it in popularity, I'm not so sure. I'd be the last gunwriter in the nation to say that the 20-gauge will eventually drive the 12 into oblivion, but I'm willing to say the 20 has made deep inroads on the 12, and not only because the 20 is lighter and usually has less recoil. The 20's popularity is growing due to its field performance. It does the job in the uplands.

It's claimed that the 12 can use more choke than the 20, and that is true. In fact, it has to since the 12 has less bore contact than the 20-gauge. For example, a 20-gauge doesn't need as much restriction as a 12 to get a full choke pattern. Bore contact may seem confusing, but it's easily figured — just a matter of determining the surface area of a cylinder whose diameter is that of the gauge in question and whose height is that of the shot charge. A 20-gauge tube is .615 in diameter so its circumference (Pi x diameter) is 1.93 inches. A 1¼-ounce load of 5s has a column length of about 1.11 inches in this gauge, so multiplying the circumference times the height gives a surface area (bore contact) of 2.14 square inches. Following the same procedure for the 12-gauge, we find bore diameter is .730 and the column length of the same shot charge in this larger gauge is .750, which gives a bore contact area of 1.72 square inches.

These are only guideline figures. Bore diameter may be slightly different in each gauge, and the column length may vary somewhat. I'm showing only the formula, not exact figures. No matter if the figures are exact or just close,

American shotshells are readily available in 10, 12 (two lengths shown), 16, 20 and 28 gauges, plus 410 bore, in shot sizes and powder charges appropriate to their normal use.



they do show that the longer column length of the 20-gauge has more bore contact than that of the 12-gauge.

We used to think that all shot deformation took place in the choke constriction. There has to be some deforming of shot in the choke, and also when it rubs the walls of the bore, but much of the deformation which takes place occurs while the shot charge is still in the case, when the rear pellets — the first to be struck by the expanding gas — began to move before the inertia of the front pellets is overcome and the whole charge begins to move. This slamming together of the pellets deforms smaller shot more than larger shot. The trip through the bore doesn't deform as many shot since the advent of the plastic shotcup as it did formerly. There is still some abrasion of shot in the bore, but the plastic cup prevents the pellets from coming into direct contact with the metal. Deformed shot lose velocity faster than spherical ones, so stretch out the shotstring. They also become many of the flyers that leave the pattern.

I'm well aware that touting the 3-inch 20 as being almost on par with many 12-gauge loads is flirting with heresy. I get letters from around the state and nation condemning me for advocating the 20-gauge at all. When I bought my inexpensive Stevens 20-gauge double barrel, the gauge was literally unknown to most of the hunters in western Pennsylvania's briar patches and grouse coverts. I bought it because I was reluctant to shoot the larger gauges. I knew nothing about ballistics at that time, but from all I'd heard, the 20-gauge was a quail gun at best. But it turned out to be a blessing in disguise. It's doubtless true that the 12-gauge is still favored over the 20, but more and more hunters are switching to the smaller bore. A modern 20-gauge over/under with 26-inch barrels bored improved cylinder and modified is a wise choice for any rabbit or grouse hunter.

The 28-gauge is heading down the same road as the 16-gauge, and that makes me mad all over. I'm more upset at manufacturers' lack of interest in the 16-gauge than I am at the 28's situation, but it makes my blood boil to see the miserable 410 still getting accolades from people who completely ignore the 28. The 28-gauge can easily handle the 11/16-ounce load of the 3-inch 410 and even another 1/8 ounce on top of that, giving better patterns all the way, yet each year thousands of new hunters, both male and female, are started with the 410. It doesn't make sense.

The same type of criticism is heaped on the 28-gauge that the 20-gauge received for many years. Since the 28-gauge enjoyed a good bit of popularity among quail shooters in the South, especially the distaff side of the family, the 28 is sometimes referred to as the "southern belle's quail gun." That seems ridiculous to me. The 28-gauge is only a small step below the 2 3/4-inch

20-gauge, and it is very effective on all types of small game up to 35 yards. When distances stretch much beyond that, the pattern of the usual 3/4-ounce shot charge thins rapidly. Tests I made at 40 and 45 yards showed many gaps in the 28's small shot charge. But the vast majority of upland game shooting is at less than 35 yards, so the 28 will do the job.

For three or four small game seasons, I spent some time afield with a 28-gauge Remington Model 1100 autoloader. Most of my hunting was in heavy stands of pines or thick entanglements of grapevines, which kept the shooting well below 40 yards. Under those conditions, I couldn't see a lot of difference between the 28 and the 20-gauge on the first shot. I did occasionally miss the heavier shot charge of the 3-inch 20-gauge for second shots.

My dislike for the 410 stems from its small 1/2-ounce shot charge in the 2 3/4-inch shell. Even in the 3-inch version it has only 11/16 ounces. This is less than the lightest load, 3/4 ounce, factory loaded in the 20-gauge. A charge of 11/16 ounce is not very large in any gauge, and it's even more of a drawback when large shot is used. Now if we go back to the deformation of shot due to bore contract, it's obvious the long column length of the 410 deforms more pellets than the same load in a 28-gauge.

I can easily recall 410 users in my community who stuck with number 4 shot. They felt such large shot produced more killing power than 7 1/2s, say, but they were overlooking the fact that pattern density is more important at normal shooting ranges. In a 11/16-ounce load of number 4s, there are only about 93 pellets, compared to 240 in the same weight of 7 1/2 shot. There are approximately 282 pellets in 11/16 ounces of 8s. Obviously, the smaller shot sizes will give much denser patterns. The fear that small shot won't penetrate sufficiently in game birds and rabbits at distances up to 35 yards is unfounded.

Don't get me wrong. The energy produced by an individual number 4 shot at 35 yards is much greater than that produced by a number 7 1/2 pellet when both leave the muzzle at the same velocity, approximately 4.4 vs. 1.3 foot pounds. Also, the 7 1/2 pellet will be moving slower at 35 yards than will the number 4.

The smaller pellet will be more susceptible to air resistance, and will slow down quicker than the larger one. There's no argument about these facts and I'm not trying to convince anyone they should be overlooked. But since small pellets such as 7 1/2s have plenty of penetration at normal shooting distances, it seems unwise not to take advantage of their denser patterns. That factor increases the chances of hitting and increases the likelihood of getting a pellet into an immediately fatal spot. Also, because there are two and a half times

as many 7½s as 4s in a given charge, the smaller shot will give more hits, so total energy input is not as different as it might seem when we look at single pellet energies. For a good many years, I have used a 1-ounce load of number 8s in a 2¾-inch 20-gauge casing in the improved cylinder barrel, followed by a 3-inch shell with 1¼ ounces of 7½ pellets in the modified tube. In heavy brush where shots are short, this combination has worked to perfection for me.

I firmly believe that certain weight shot charges are more compatible than others with a particular gauge. It's possible to stuff a lot more pellets into a 2¾-inch 20-gauge case than the 1-ounce load most reloading manuals recommend as maximum (some of the 2¾-inch plastic cases will take 1⅛-ounces of shot). However, when heavier than recommended shot charges are used indiscriminately, there could be a dangerous surge in pressure. It's also likely that more shot will be deformed, which means pattern quality will certainly suffer. The 2¾-inch 20-gauge case is at its best, to my way of thinking, with 1-ounce shot charges. The 3-inch case was designed for 1⅛ and 1¼-ounce shot charges. Some shotshell handloaders won't accept this, and continue to load heavier shot charges in the 2¾-inch hull in hopes of getting denser patterns. No handloader should ever go beyond the charges suggested in the latest shotshell reloading manuals. (It's wise to discard older manuals as recommended loads change over time due to changes in components.) Primers and powders have changed over the last twenty years, and shotshell reloading manuals from the 1950/60 era should be checked against later editions.

I hope this conglomeration of facts and figures will throw some light on the shotgun gauge situation. There will always be controversy and strong opinions. We have six shotgun chamberings with us today because not everyone would be satisfied with just one, no matter how efficient it was. We are governed a good bit by our psychological side. During many of the years I used the 20-gauge, I didn't have the benefit of the 3-inch chambering. My older brother Cull used to shake his head in despair at my unwillingness to go to the 12-gauge. More than once, when I missed and he connected, he would good naturedly explain the superiority of the 12-gauge. Sometimes he took advantage of a fortuitous situation.

For example, on one occasion, Cull's dog routed a rabbit that headed toward a tiny creek. I fired a half-second after Cull's 12 boomed. My shot charge tore up the leaves on the opposite bank of the two-foot wide stream, but Cull's stopped the rabbit instantly at the edge of the creek, as if it had run into a brick wall. Closer examination showed the cottontail had stuck in some protruding roots and vines. If it hadn't been for them, the rabbit would

Ithaca's magnum 10-gauge autoloader, designed by Jim Tollinger, left, proved deadly on long range Canadas, but for grouse in the thick stuff, an open-bored double such as Ron Lantz's Savage Fox Model B is a better choice.

have landed in the creek. There would have been nothing to stop its momentum.

But Cull purposely ignored the real reason the cottontail had come to such an abrupt stop and needled me for an hour on the stopping power of the big 12. He pointed out, in great detail, how the 12-gauge would "pin" them to the ground, using his last shot as pure evidence of the mighty 12's stopping power. He expressed amazement that I had the audacity to think the rabbit would get to the other side of the creek when he was there with his 12-gauge. He thought it terribly foolish that I would waste a shell shooting at a place the rabbit would never get to. Cull knew how to get me riled. We had a lot of good hunts together, but he was too sharp for me to get ahead of.

Many gunwriters suggest certain gauges for different types of game, and there could be some merit in that type of thinking. I have always believed the fit of a shotgun was more important than the gauge for most types of small game hunting. Since we can come close to duplicating some 12-gauge loads with the 3-inch 20, the advantages once held by the 16 and 12 are not as significant as formerly. Recoil should be taken into consideration when buying a shotgun. Young hunters, in fact, anyone who is bothered by recoil, would be better off with a 20-gauge.

Getting the most from any shotgun, regardless of its gauge, depends on knowing how it performs on the patterning board. This will never be learned in the field.

After the initial cleaning and examination of any new shotgun, and familiarization with it, the next step should be patterning. Conventionally this is done at 40 yards. One of the early English gunmakers indicated this distance was chosen because it was far enough that the pattern variations resulting from different chokes were obvious, yet not so far that patterns disintegrated completely. Over the generations, so much testing has been done at this range that anyone who wants to know how his gun and loads fit into the overall scheme of things must do his firing at 40. But the hunter who is primarily — or exclusively — interested in knowing his pattern diameters and densities at his usual game shooting distances could well do his testing at another range or ranges. Waterfowl hunters, for instance, might want to know if it's reasonable for them to try for geese at 50 or even 60 yards. As a shotgunner who is mostly a grouse and rabbit shooter, I'm interested in knowing what I can expect from a given combination of load and choke at much closer range, so I do most of my patterning at 30 yards. You might prefer some other distance — 25 yards, say, which is what the skeet shooters choose. Here's an inexpensive method for patterning your shotgun.

It's wise to buy large sheets of paper for patterning, but newspaper sheets will suffice although they are not large enough to draw a 30-inch circle on. Stretch the paper over some type of backboard or frame, and paint or spray a 4-inch bullseye in the center (I cut a round hole in a foot-square piece of heavy cardboard and spray through it; this keeps the bullseyes the same diameter). From a 30-yard rest, take dead aim and pull the trigger, much as with a rifle. Remove the old sheet and put up a new one. Repeat the shooting process (I like to fire the first five shots from sandbags on a rest such as a folding ironing board). Don't bother to check concentration of pellet count until you have five targets to work with.

I drill a hole at the 15-inch mark in a common yardstick so I can fit a pencil or felt-tipped pen through it, then drive a small nail at the very end of the yardstick, allowing 1/8-inch of the point to protrude. I place the nail point in the center of the bullseye, and by rotating the yardstick around it draw a circle 30 inches in diameter.

By holding each sheet up to sky, you will be able to see where the shot concentrated in respect to the bullseye. Next, count the pellets inside the 30-inch circle. Do this with each target and divide the total by five to get an average. I'm including a table of pellet count for different weight charges, but you can also open a shell and count the pellets. Divide the average

number of pellets in the 30-inch circle by the total amount in the shot charge, and this will give you a decimal percentage. The percentage you get at this point may not be impressive. You will probably discover that the heaviest concentration of pellets is slightly above the bullseye. Move the nail point to the approximate center of the shot concentration and make another 30-inch circle. Repeat the process, as before. The decimal percentage should go up considerably.

Draw vertical and horizontal lines through the center of the second 30-inch circle. This divides the circle into quadrants. Count the pellets in each quadrant and divide the total number of pellets in the circle into the amount in each quadrant. This will give a decimal percentage for each quadrant. You will probably find the top two quadrants to have a few more shot in them than the lower two.

That finishes stage one. Stage two is firing the shotgun in hunting fashion, by shouldering it rapidly and shooting the instant the barrel aligns with the bullseye. When this test of five shots is over, you may be shocked to find that your pattern concentrations in hunting fashion formed on a different area of the target than the ones fired from the bench.

If it's evident that the particular load being used is not forming consistently even patterns, and several or more palm-size gaps appears in most of the targets, go to the next size smaller shot. It's generally agreed that 4 to 6 hits are needed on pheasant-size game to assure a clean kill. This is somewhat hypothetical, but it establishes a guideline. Unlike the jacketed rifle bullet which can be accurately guided to a target, each individual shot pellet is on its own after leaving the muzzle. Some will fly a true course, others will wander, and the laggards might arrive too late to do any good. The shotgunner has to depend on pattern density for success. There's no doubt that's the important factor in hunting with a smoothbore.

Not many gaps will show up in patterns fired at 25 yards or less. I believe in patterning rabbit and grouse outfits at 30 yards, but it's not a bad idea to see what type of results are obtained on a 45-yard target. This would be of interest to the dove and waterfowl hunter. One thing for sure, there will be some very noticeable gaps in the 45-yard target.

A turkey-hunting friend uses a cardboard template of a turkey's head and neck to draw outlines in his patterns. He places the cardboard cutout (made to approximately the actual size of a turkey's head and neck) on different places in the pattern and draws a heavy outline around the template. This lets him see how many pellets would have struck the turkey's head and neck. He shoots three to five patterns at one distance, and then averages the pellet count to see how that particular load "kill-patterns," as he calls it, at various

distances. He is methodical, and keeps an accurate record of various shot sizes at ranges from 20 to 45 yards.

As you can see, patterning shotguns is time-consuming work. Furthermore, you should pattern every brand and type of shell you intend to use for hunting, and do so in every barrel you will be using it in. Firing a couple shots into an empty anti-freeze can is not the proper way to pattern a shotgun.

Now, I could to on and on with other suggestions, but the goal of shotgun patterning is for you to find out how your particular shotgun delivers its shot charges at various ranges and, every bit as important, to learn where the pattern forms in relation to where you were pointing. Don't expect the patterns to be in the center of the paper, just because the bullseye is painted there. Comb drop, butt pad pitch, the way a shotgun is held and many other factors all have a direct bearing on where the pattern forms.

One bitter cold morning, a hunter asked me to pattern his new 12-gauge pump which had a choke selector on the muzzle. He had received the gun as a Christmas present, but his luck with it during the late small game season had been terrible. He hadn't bothered to pattern it, as he thought all new shotguns were patterned at the factory.

I had no intention of running a long series of pattern tests in temperatures hovering just above zero, but I agreed to take a couple of shots. The new pump shot surprisingly consistent patterns at 30 yards, but they centered about a foot low and a good two feet to the right of the aiming point. After a dozen or more rounds, we decided the external choke was installed improperly. I gave him an invoice explaining what I thought was wrong, along with several targets. He told me later he received another new slide action outfit in exchange for this one.

Most hunters do not pattern, due to the amount of work involved. They are willing to assume, much like the man with the slide action 12-gauge, that the factory checks all shotguns for pattern density and placement. That is not true, although I'm sure they conduct a lot of tests. Shotguns pattern differently with different sizes of shot. The center of the overall pattern may not be the densest part, as many hunters expect. There is no way of knowing where the pattern will form until a dozen or more shots are fired at paper targets.

If you are a shotshell handloader, you can work up certain loads that will improve your shotgun's performance on the patterning board. Information gathered from the patterning target may not give concrete answers, but the load that consistently prints the most even patterns at normal hunting ranges is the one to use in the field. Look for gaps in patterns. I once used a battered

12-gauge double that threw clusters of shot. Ten to twenty pellets would land in an area the size of grapefruit, but the cluster would be surrounded by large areas of untouched white. The old 12's usual pattern left openings big enough for a grouse to fly through. I never figured out the reason for the shot clustering, but decided it was a result of the old double being cut back to 26 inches. That in itself might not have been too bad, but each barrel had also been swaged out slightly at the muzzle, in an attempt to remove all the choke. That old double ended up in the parts bin.

It's not unrealistic to estimate that more than 75 percent of all shotguns currently being used for small game hunting have not been patterned properly. When I was working on guns, I encountered this dozens of times. Strange as it may seem, the hunter always had to be persuaded to have his gun checked. In other words, field results were so poor the hunter felt something was wrong with the shotgun, but few, if any, thought the answer for such poor shooting rested with the shotgun's pattern or impact point. Most believed the barrel was defective or the type of shell being used was wrong. One man who missed consistently with the left barrel of his 16-gauge was amazed to learn that despite its full choke marking the barrel wasn't full choke at all, and that at 30 yards it shot more than a foot below the right barrel. A dozen shells at a patterning board would have brought these facts to light and saved him three hunting seasons of frustration.

Patterning a shotgun is not a waste of ammunition. It's the only way you can tell how shot charges perform at given distances. One handloading rabbit hunter, who faithfully stuck with high brass shells and number 5 shot, discovered to his chagrin that his shotgun produced the best patterns with low velocity loads of 7½ shot. He could hardly accept this but it was true, and therefore worth knowing.

Shotgun Chokes

I HAVE SAID that the subject of choke is cloaked in mystery. It has mysterious fascination for a lot of small game shooters. In their minds, full choke means long range, and this indicates power. Most all single shot outfits seen in the field carry full choke barrels. Full choke, along with barrels running from 30 to 36 inches, spelled long range effectiveness to the gaslight era hunter as well. The old Stevens "Dreadnaught" single shot, with its 36-inch barrel and "full taper choke" boring, was advertised as a "super range" outfit in long gone days.

The American hunter has always been obsessed with power in hunting rifles and shotguns. Our pioneer forefathers used large bore muskets, and it wasn't until the middle 1700s that rifle calibers became smaller, but they were still between 45 and 60. Among the most effective were various large caliber Sharps cartridges used by the buffalo hunters in the 1870-85 period. These large calibers died out along with the buffalo, and also because new components and a better understanding of ballistics made small calibers more efficient. Today, we have evolved from the large bores to magnum shells in both rifles and shotguns, so we're still on the long range power road. There's a paradox here; power, long range potential and tight choking actually have the lesser of two roles to play in normal small game hunting.

Over a four-season period under all types of hunting conditions, I stepped off every rabbit and grouse kill I or one of my hunting companions made. It only took 25 steps, on average, to pick up the rabbit or grouse. That's about 15 feet farther than the pitcher's mound is from home plate. I doubt if anyone would categorize that distance as long range. I have lost the notebook that had the details on these hunts, but I think it took 48 steps to reach one kill made on a crippled rabbit and, during that long span of time, possibly only a dozen other successful shots stretched the distance to 40 yards

or more. Where do extra power and tight choke fit into this picture?

A lot of small game hunters stick with the 12-gauge because they believe it shoots harder. Today, we have the magnum syndrome in the rifle, handgun and shotgun realms. I honestly believe there's little rhyme or reason in such hard-line thinking. Many times shotgunners overlook important shooting aspects such as pattern density and shot size. They are power oriented. I remember some years ago I was field testing an Ithaca Model 280 SKB 12-gauge side-by-side with 2¾-inch chambers. It was a wonderful little gun. I showed it to an avid small game hunter who was looking for a lightweight double. He didn't use many words in telling me he'd never consider a shotgun that wouldn't handle 3-inch shells. He couldn't give a valid reason for his philosophy but kept insinuating the 3-inch case, with its larger shot charge, added yardage. There's some truth in that, but it's rarely important in upland hunting. I believe a 2¾-inch 12-gauge load will handle more than 95 percent of the shots in this kind of hunting. This hunter's attitude was just part of the magnum syndrome.

In America, we give credit to Fred Kimble, a waterfowl market hunter from Illinois, for discovering choke. About 1875 an Englishman, William Pape, was given an award for patenting a barrel boring system that apparently included some choke constriction. However, in 1874, W. W. Greener had already been working on a method to produce choke constriction. In 1875, comprehensive range tests were fired pitting cylinder bored shotguns against choke-bored outfits. Greener's choke-bored guns won hands down, and literally revolutionized the shotgun-making industry.

Other gun makers must have been involved in the process, but it's really immaterial who invented choke. The important thing is that we have it. It's fairly well established that choke was born in the late 1800s; before that all shotguns had cylinder-bored barrels.

The magnum shotgun syndrome probably started soon after choke was discovered. Shotgun manufacturers in black powder days claimed 50- to 60-yard kills for their full choked barrels — claims like many made in today's advertising. Long range efficiency was important then because waterfowl hunting was in vogue at that time. But the best of the cylinder-bored guns were putting only 80 to 110 pellets from 1⅛ ounces of number 6 shot in a 30-inch target at 40-yards. That's approximately a 40 percent average. However, the Greener and Kimble choke bored guns were averaging over 200 pellets from the same charge, for an 80 percent average. In one test against a very fine English 12-gauge cylinder bore, a Greener 12-gauge choke outfit consistently put 60 more 6s on the 30-inch target, firing the same load.

No one could blame the hunter of that era for having an implicit faith in

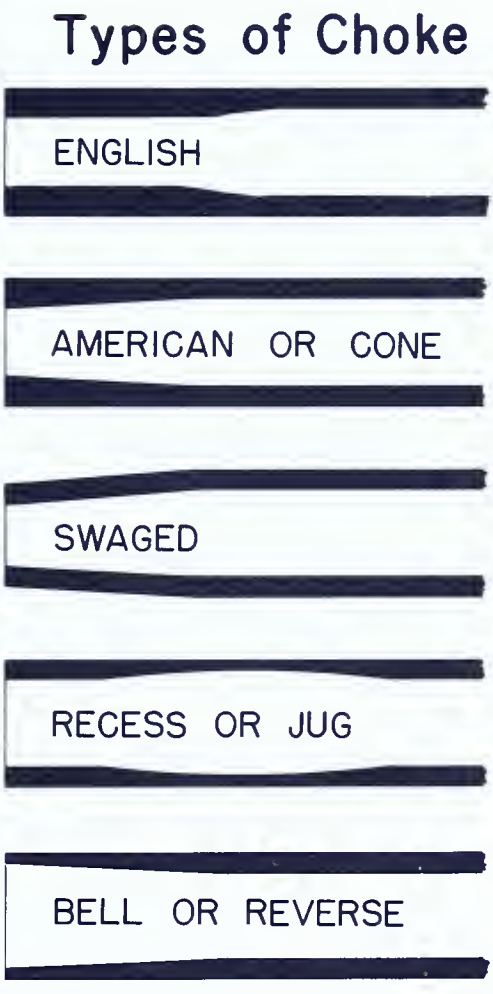
choke, but it also created the belief that choke always added considerable yardage to a shotgun's effective range. In theory, that is true, but in a practical sense tighter patterns are of value only if the shooter has the ability to hit at long range. When pattern diameter is cut significantly, the shooting must be more precise. Tight patterns really work against the shotgunner at short range. It's true that a full choke pattern will be smaller and denser at 45 yards than one from an improved cylinder, but it's also true it will be much smaller and denser at 25 yards and here it's a disadvantage. You can't have your cake and eat it, too.

I doubt if Fred Kimble's 9-gauge muzzleloader had its choke constriction stamped on the barrel, but it was probably as tight as he could install. Tradition says it did produce super patterns.

As choke constriction became more understood, gun builders began installing choke by degrees. At first, Kimble, Pape, Roper and others swaged their constrictions by trial and error, probably until they got what seemed to be optimum patterns with an acceptable load. It's interesting to note that American gunsmith S. H. Roper received a patent in 1866 for a "screw-in" choke. I wonder why early American shotgun builders didn't latch onto Roper's idea, as screw-in tubes should be easier to build than reaming or swaging a certain degree of choke into the bore. On top of that, such chokes add versatility to a shotgun. Today, Roper's idea is back in full force as many gun manufacturers offer their own versions.

There are three primary degrees of choke today: full, modified and improved cylinder. A full choke barrel puts at least 70 percent of the shot change into a 30-inch circle at 40 yards. Modified drops to around 60 percent and improved cylinder, 50 percent. There are variations of some of these chokes, such as improved modified (sometimes called 3/4 choke; it should put 5 or 6 percent more pellets in the 30-inch circle than modified), and skeet choking, which has only a slight amount of constriction. Skeet No. 1 is essentially a true cylinder, with only enough constriction to form up the pattern a little. Skeet No. 2 is about the same constriction as improved cylinder, or a bit more open. I suppose if a hunter is willing to spend enough, any degree of choke can be obtained from one of the top barrel people. It's well to keep in mind that not all shot sizes deliver the same pattern percentage from a given choke. There's no way of predicting what a given barrel will do with different loads. The only way to get a reasonable idea is by testfiring.

I guess I'd be remiss if I didn't compare a choke to the nozzle of a water hose. Every gunwriter in the last hundred years has done so — because it's a nearly perfect illustration that even non-shooters can visualize. Everyone knows that as the nozzle is screwed tighter, the water is compressed into a



Different kinds of chokes have been developed over the years. These are probably the most common of the permanent styles. Adjustable or interchangeable chokes are also available.

narrower stream and thus has a smaller impact area. Increasing the constriction of a choke does the same thing to shot pellets. Up to a point. Anyone who has used a hose knows that tightening the nozzle past a certain point does not compress the stream further; it actually opens it up to a spray. The same thing happens to a shot charge if too much choke is used. So there's a fine balance point to be worked toward, if the most effective long range combination is wanted.

An adjustable unit such as the Poly-Choke works on much the same principle. As the outer sleeve is tightened, an internal tapered sleeve forces fingers in the choke device together slightly, forming a tighter choke. Turning the sleeve in the opposite direction opens the fingers, thus decreasing the amount of constriction. The famous Cutts Compensator was different. It was a series of interchangeable tubes, each with its own degree of choke, designed for effectiveness from 20 to 70 yards. There were and are others. Mossberg has been installing the C-Lect choke on their Model 500 pump shotgun for decades, while the Noble slide action outfit came equipped with a Multi-Choke that made it "9 guns in 1," with twist of the wrist. Today, we have a variety of screw-in tubes. Winchester's Model 59 autoloader was available with three such chokes in the mid 1960s. It's reasonable to assume the screw-in choke will become standard on most shotguns.

I have often thought that the ideal upland shotgun would be a double barrel outfit bored cylinder and full. To my way of thinking, that makes

sense. Ream one barrel as open as possible and the other as tight as possible. This would be the epitome of opposites. I have suggested this to shotgun manufacturers, but got only icy stares; the hunter wants modified and full in double outfits, they told me. If cylinder/full is too unorthodox, let's try improved cylinder and full. Now, that can be had in some expensive two-barrel creations, but why not give a break to those of use who can't afford $3,000 outfits. IC and modified are common borings today. Why not go a step further and make an IC/full outfit. Perhaps that's too much of a break from tradition, but I don't hit rabbits and grouse with tradition; I need a shotgun that gives a wide pattern at 20 yards and a tight one at 40. Results count more than tradition with me.

The effective improved cylinder range, so many experts claim, is roughly at 20 to 30 yards. At 20 yards, nearly all the pattern is inside a 30-inch circle. Pushing it another 10 yards opens it up quite a bit. At 35 yards, only about half of the pellets are in what can be called the "killing pattern." In other words, the most effective pattern is between 20 and 30 yards. I realize these are only guideline figures, but they are probably close. I would be willing to use the IC pattern to 35 yards, but it would depend a good bit on the size of shot.

Ideal shooting range for the modified choke is between 25 and 40 yards, and for full choke it runs between 30 and 50 yards. Choosing a full choke for cover where shots will average 20 yards is defeating its purpose. The full choke single shot user soon learns to hold back until his target is far enough away to be in the maximum effective spread of the pattern. Modified boring sometimes is called half-choke, apparently because it's about halfway between cylinder bore and full. On a single barrel shotgun, modified is the favorite of most hunters. It's a happy medium choke boring.

I may be going against tradition again, but I'm of the opinion that IC choking is the wisest choice for rabbit and grouse hunting. I've hunted with fellows using full choke tubes because, "where they come from the shots are longer" or they "like to take more time." There is merit in such a viewpoint, but I noticed that, contrary to what they claimed, they often fired before the rabbit or grouse got 25 yards away. Remember the old veteran with the 12-gauge double barrel who said "let them get out a piece"?

Full choke has such a stranglehold on so many hunters that it's hard to convince them less is often better. We are ingrained by the past, and the tight choke philosophy was born in an era when small game was abundant. Long before I was out of high school, I hunted with an 80-year old man who enthralled me with stories of his hunts from the past. "Me and my brother got 18 rabbits before dinner in the Old Harlington farm. We hunted only in

the apple orchard and a five-acre cornfield. Why, in '03 I bought a Savage 22 pump that had a 7-shot clip. When the first good tracking snow covered the ground, I put my Remington 12-gauge double — it had 32-inch barrels, both full choke — above the mantle and hunted with the 22 pump. Rabbits were everywhere, and I had no trouble getting a half-dozen right in the nest. It was a big savings on shotgun shells."

Why would gun designers of that era stick almost exclusively with long barrels and tight chokes when small game was abundant? With the exception of waterfowl, black powder hunters weren't usually faced with long shots. I can recall a little bit about small game hunting in 1930-33. I think the daily limit on rabbits was five and, with three hunting brothers, a dozen or more rabbits often hung from the roof joists on our back porch after a hunt.

When I got my first hunting license in 1935, most of our rabbit and grouse hunting was in heavy brush or thick grapevines. It seems to me a wide open choke would have been the proper approach.

I'm not picking on the 12-gauge, but I have to point out that many of its followers are mistaken when they claim that it has much higher velocity than the smaller gauges. Actually, the shells of all regularly available gauges from the 3-inch 12 down to the 410 bore have essentially the same velocity, according to the manufacturers' own listings. As given in the current *Gun Digest,* nominal velocities of lead shot hunting loads are: 12-gauge 3-inch, 1175-1375 feet per second, according to the load; 12-gauge 2¾-inch, 1220-1330; 16-gauge 2¾-inch, 1165-1295; 20-gauge 3-inch, 1185-1200; 20-gauge 2¾-inch, 1165-1220; and 410 bore, 1135-1200. The differences here are not significant, especially when we consider how much variation there can be in any ten shells.

The Winchester-Western "Ammunition Handbook" sums it up this way: "There is added evidence that the two important factors in shotgun range . . . are the degree of choke in the barrel and the number of shot (weight) in the shell. Complex calculations and collective field experience indicate that each quarter ounce of shot added or subtracted means adding or subtracting 3 to 5 yards of range, probably 4 over the average.

"In other words, where the original 68 percent or full choke gun with 1¼ ounces of shot might kill ducks with very reasonable regularity at 45 yards, with a 1½-ounce load of the correct shot, it could be expected to perform satisfactorily at 50 yards. But if the shot load were reduced to only 1 ounce, its limit would be 40 to 42 yards even with the same choke.

"The selection of shot sizes for specific gunning jobs depends on the type of target. The selection of the gauge depends largely on the gunner's ideas of desirable gun weight and recoil. Therefore, it may be said that, regardless of

Some of my favorite grouse guns, four 20s and one 12: SKB double, both barrels IC; M37 Ithaca Featherlite pump, IC; Ruger Red Label, IC/M; Remington 1100, IC; and Mossberg 500 12-gauge with C-lect choke. All are fast handling in the densest cover.

the gauge, the shot weight determines the density of the pattern and therefore the effective range of any given load, and that each degree of choke is worth approximately 5 yards in range."

I think this quote should definitely point out that gauge is not as important as many hunters believe. Some of my magazine articles have raised the hackles of the 12-gauge crowd when I made similar statements, or when I said that the modern 3-inch 20 gauge's 1 1/4-ounce shot charge produces patterns as tight as the 2 3/4-inch 12-gauge with the same weight shot charge. The way I see it, the shot weight and choke determine the density of the pattern, not the gauge.

The amount of constriction needed for each choke varies with the bore size. For instance, to obtain a full choke pattern in 12-gauge, 0.40 constriction might be required, while 0.30 could do it in a 20-gauge and 0.45 might be necessary in a 10-gauge magnum. These numbers are approximate, but they illustrate what I'm saying.

Several choking systems have been used over the years. Usually they are intended to tighten patterns from those that would be delivered by a straight cylinder bore, but one is designed to open the pattern even quicker, as for use on International skeet or perhaps woodcock shooting in the densest cover.

The least expensive choking method is simple swaging, as used on some single shot utility guns. With this method, force is applied to the outside of the barrel near the muzzle, reducing its diameter on a taper. This is a comparatively crude approach, but it works reasonably well. A more sophisticated variation of the same basic method is to machine the barrel so that it originally has an enlarged taper on the outside of the muzzle. Then pressure is applied externally, transferring the taper to the inside. This method assures that that outside of the barrel is the same final diameter over the choke area as the rest of the barrel.

Another method leaves some extra metal inside the bore near the muzzle when a barrel is being drilled and polished to size. The inside area is then carefully reamed and machined to the desired choke dimensions. Sometimes the choked area is positioned slight behind the muzzle, to give a short parallel-sided bore section at the end of the bore. Yet another type of choke can be installed in a barrel which has none — usually because the barrel has been shortened for some reason (often because it was fired with an obstruction such as mud near the muzzle). In this case there is no extra metal to work with, so a short distance behind the muzzle the bore is enlarged slightly for a couple of inches. This allows the shot charge to expand when it comes to the relieved section and then be compressed slightly when it reaches the front end of the enlarged area. Usually the barrel isn't thick enough to allow a deep recess, so choke restriction can't be great, but it can be worthwhile.

The objective of the described choking methods is to constrict patterns and perhaps eliminate thick and thin areas — sort of even them up. Occasionally, under special circumstances, shooters want a more open pattern than even a cylinder bore delivers. For these, the muzzle can be flared a bit.

Another method of choking is the use of adjustable units attached to the barrel after the regular choke is polished out or cut off. The Cutts Compensator and the Poly-Choke, discussed earlier, are the two oldest such systems I can think of. Screw-in chokes, also discussed, are the latest.

After 50-plus years of small game hunting, I've concluded that most hunters are overchoked. They are geared for 45-yard shooting, when 90 percent of their shots will be fired at less than 30 yards. A fellow I knew who had trouble getting the scales past the 125-pound mark purchased a Winchester Model 12 Magnum Duck Gun, which he claimed would make the "perfect squirrel outfit." When he brought his new outfit to the country store one evening, it drew more attention from the assembled "hunting experts" than his brand new 1958 Ford parked outside. He was assured in strong terms that he had hit the jackpot. The new gun's full choke 30-inch barrel in conjunction with 3-inch magnum shells stuffed with number 4 shot would make him the number one squirreler in the area, everyone agreed. They also agreed he would be able to kill rabbit and grouse from one end of a woods to the other. He had the ultimate in a small game shotgun.

A few years later, I ran into him on a rabbit hunt. To my surprise, he was carrying a 20-gauge pump with a modified barrel. The big magnum had been sold. Nothing had worked as expected, he told me. A few squirrels fell, and a shot now and then connected on a distant rabbit or grouse. But at close range

the full choke magnum was a ditch digger. What he did hit, he couldn't eat. On top of that, each shot nearly dislocated his shoulder. His love affair with the magnum was short-lived.

The prime purpose for choke constriction is to control the size of the pattern at normal shooting ranges. The ultimate goal is to have a pattern of sufficient diameter and density for most of our field shooting. There are two main characters in this little drama: choke constriction and shot size. A pattern that is too wide at normal ranges will generally be too thin to be effective. An example of that would be one delivered by the IC choke with large shot. It obviously wouldn't work well on doves. Pass shooting at doves usually means long range shooting. Distance is difficult to measure in an open sky, and dove hunters often try 35- to 50-yard shots. To get the density needed to hit those small birds, the shot charge must be made up of smaller pellets. A dove is a small bird, and can sail unscathed through a thin pattern of number 5s at 45 yards. A full choke barrel will reduce pattern diameter, increasing the density but making it harder for the hunter to connect. The use of smaller shot — 7½s or 8s, say — will thicken the pattern, even in an open choke, cutting down the chances of missing. There are approximately 213 more pellets in a 1¼ ounces of number 8s than there are in the same charge of 5s. An extra 213 pellets in a shot load is too important to overlook in dove hunting.

The 12-gauge has a number of followers who believe its pattern is larger in diameter than that of smaller gauges. That isn't so. Patterns from all gauges of the same barrel length, choking, and shot charge have the same diameter at any given distance. Once, after I made that statement in an article, I received a letter from an avid 410 admirer who claimed the 410 bore was the exception. He conceded it might be true with all the other gauges, but claimed the 410 bore had a smaller pattern diameter. Since the next 410 I will shoot is not on this or next year's schedule, I won't argue with him.

When we examine a pattern after firing, it shows a lot of holes in a flat peice of paper. We count the pellets, average them out, and are convinced our shotgun is putting 70 percent of its total shot charge in a 30-inch circle, say. This is a full choke pattern, although many guns will give a higher percentage. But there's one thing wrong: we are looking at the end result. What we don't know is how long it took all of the shot to reach the pattern board. A high speed camera would reveal that the pattern doesn't form instantly. It does not move through the air in a pie pan shape as it appears on the patterning board; rather, it is stretched out in a three-dimensional mass, perhaps two or three times as long, front to rear, as wide. At least some of the trailing pellets contribute to the pattern shown on the stationary board (a

A typical adjustable choke. Most function as a collet, bore diameter being enlarged or decreased by rotating a sleeve. This system works well if properly installed, but if not precisely done pattern might not center where it should.

small percentage probably angle off and are lost). However, a flying bird continues to move while the shot string is in the air, so if the leading pellets are on target a crossing bird's movement might take it out of the path of the trailing pellets before they arrive. Thus some pellets which count toward a pattern's density on a motionless sheet of paper might not contribute to a shell's efficiency on a given shot.

I once swung ahead of a fast-moving honker and fired. It never lost a wingbeat, but a goose some 15 feet behind came down with a thud. As near as I could tell, a single pellet in the head ended the flight of the second goose. My lead on the first goose apparently was short, and the main shot charge went behind it. I'm convinced the second bird was the victim of a pellet in the tail end of the shot string.

A lot of thought should be given to the amount of choke constriction needed. Don't go for the idea that the more choke you have the more successful you will be. Also, don't attempt to determine the degree of choke by using a homemade measuring system. I am not ashamed to admit that in my younger days, I "carefully" measured choke with everything from seeing if a dime would slide sideways into a 12-gauge barrel to trying to feel the choke with my shooting finger. This admission is good for a laugh today, but I was just copying what other hunters were doing back then. Not long ago, a phone caller wanted to know if his barrel was full choke because it wouldn't accept a dime. The dime theory is hogwash. Dimes vary significantly in diameter when thousandths of an inch are important. It's tough to measure choke constriction even with precise inside calipers.

In black powder days, tight choking was in vogue. With today's progressive powders, less choke is needed. Admittedly, the development of choke affected shotgun shooting noticeably. Choke converted the shotgun

barrel from a blunderbuss to a highly efficient shooting machine. Choke made it possible to have some control over the spread of the shot charge throughout its flight. However, despite all the improvements choke makes, it can also be a hunter's Archilles' heel if the wrong amount is used.

I'm basically a rabbit and grouse hunter. I seldom fire beyond 35 yards. If you recall, my tests over a four year period showed my average rabbit and grouse shot was only 25 yards. Here you can see the advantages of the improved cylinder boring for the cover I hunt in. A quick-opening pattern makes it possible for me to consistently connect at distances between 15 and 30 yards. Compare these figures with about a 20-inch pattern at 20 yards and only 30 inches at 30 yards from a full choke tube. It's obvious my success ratio would not be the same.

Most hunters of pre-WWII days never saw a ballistic table. In my younger days, shotshells were tested for power by shooting into mail order catalogs. The shell that put its pellets through a few more pages than the others was considered the most powerful. We were misled by the one or two pellets that penetrated the most pages. We gave little thought to the number of pellets that hit the catalog, or the fact that total power is not the only criterion to judge a shotshell by. And we didn't realize that a half-dozen shots did not constitute a real test. Looking back, it's easy to see that our tests were crude, but we took them seriously. Now, I know much of what we thought to be true was completely false. However, despite our ignorance we killed a heck of a lot of game. But I'm now sure that if I'd used smaller shot and less choke, I would have been more successful.

The term "scattergun" should be dropped from the shooting dictionary. Every gunwriter in the nation, myself included, uses this term freely, but it's a misnomer. The shotgun throws a reasonably controlled expanding shot charge of lead or steel pellets; it doesn't scatter them like a handful of rice at a wedding, but that's what the term "scattergun" implies. Worse yet, the term gives credence to the belief that a shotgunner can't miss.

Choke controls the shot charge's rate of dispersion. This dispersion helps overcome small pointing errors, but it doesn't guarantee that every pellet will connect. For general small game hunting, tight chokes work against the hunter. Game is not as abundant as in the past. Consequently, today's hunter doesn't get as much shooting in the field and, for this reason alone, he should be selective about the amount of choke used. For upland hunting it's better, to my way of thinking, to be slightly under-choked than over-choked.

Shotgun Fit

IF THERE IS a term that can be considered ambiguous, it's shotgun fit. The fit of a shotgun, like beauty, is subjective at best. Gunwriters have wrestled with this term for decades, but fit in shotgun terminology is still as difficult to describe as beauty. Beauty may be in the eye of the beholder, but the fit of a shotgun must meet the physical configurations of a hunter's body. Writers get careless at times, and claim that the fit of a shotgun can pretty much be determined by the frame makeup of the shooter. That sounds reasonable, and it does work in many cases. Still, there are tall shooters with short arms and short shooters with long arms. And how many shooters, regardless of height, have the same jowl thickness or neck length?

Now you're getting some idea of the variety of ingredients involved in the fit of a shotgun. It's not just placing the butt pad in the cradle of the elbow to see of the shooting finger reaches the trigger, as many advise. That's part of this complex puzzle, but it's not the only thing to consider.

I have many times referred to shotgunning in the field as "reflex shooting." Unlike the claybird shooter who is standing on a concrete pad with the gun properly mounted and the buttplate firmly in the shoulder pocket before calling for the bird, the small game hunter is at the mercy of the cover, the weather, and the element of surprise. Instead of calling for the target when he wants it, it's likely the hunter will be in the middle of a grapevine entanglement or have both feet snagged in a greenbriar patch when the action begins. There's precious little time to get the gun up and fit the butt pad properly in the shoulder pocket. Unfortunately, if the shotgun doesn't come up in one fluid motion and snug firmly into position, the odds are on the side of the disappearing target. The make, model and gauge of the gun are of little consequence if it doesn't fit as it should.

In 99 percent of the cases, the hunter blames himself for a miss. Most of us

find it hard to believe that the fit of the shotgun had anything to do with it. I have been asked dozens of times — "What's so important about the fit of a shotgun?" The answer is simple. Proper gun fit is a prerequisite for consistently good shotgun shooting. It's doubtless possible to learn to shoot well with a gun that doesn't fit properly but that's certainly doing things the hard way. A stock of the right dimensions means you don't have to overcome various unnecessary obstacles on the road to hitting. When you throw a properly stocked gun to the shoulder, everything fits instantaneously. The length is short enough that the butt doesn't drag against the jacket coming up, yet long enough that the nose of the comb holds the thumb away from your nose in recoil. Comb thickness positions face horizontally so that the eye is looking straight down the centerline of the barrel or the rib, and comb height positions the eye at the proper level, so that about two-thirds of the pattern strikes above the front bead, one-third below. All of this results in proper gun alignment. When a bird flushes, you concentrate on it as you flip the gun up, and the gun automatically inserts itself into your sight path. You don't have to fight it or force it. You simply look at the bird and slap the trigger and the bird falls. That's why proper gun fit is important.

A moment ago, I stated that one way of checking fit is to see if the shooting finger reaches the trigger when the buttplate is cradled in the crook of the elbow. Basically, this deals with only the length of the stock, and it's a rough guide at best. Stock length is the Achilles' heel for most shotgun users, for no two are physically identical. The gunmakers can't possibly supply stocks in graduated lengths, so they try to fit a theoretical average. They tend toward the long side, as this makes it possible to cut down if less length is wanted. It seems to me it would be just as easy to add length, by means of a recoil pad, if needed, but nobody else sees it my way, so factory stocks come through with 14¼ to 14½ inch length for the most part.

The long stock theory is also based on the dubious claim that the modern shooter has a larger frame than his forefathers. I doubt that, but if it is true, this still doesn't rule out the fact that literally millions of hunters aren't large framed or tall. I'm just five foot nine, but I don't have to stand on a wooden box to be face to face with a high percentage of the younger generation. I think the 14½-inch stock came right out of the trapshooting clan. In fact, trapshooting has done much to influence shotgun design over the past few decades. The long stock and the 32- or 34-inch barrel are right at home on a trap gun, but the hunting shotgun is a far cry from a trap gun.

I don't like a 14¼-inch stock for two reasons. First and foremost, it's almost an inch too long for me (I cut my stocks down to 13⅜ inches from the face of the trigger to the center of the buttplate), and secondly, it's wrong to

offer just one length to the hunting fraternity. This is just the same as making a nonadjustable car seat that fits only tall drivers. What if a boot manufacturer made nothing but size 12s? It's preposterous to think that one length stock on any type of rifle or shotgun will fit all shooters. Admittedly, the rifleman usually has time to adjust to imperfect stock length, but that's not true with the shotgunner. Again, we go right back to reflex type shooting — just flush, swing, shoot. There is not one shotgunner reading this who hasn't experienced what I call reflex shooting. It's a normal part of small game hunting, but to do it successfully requires a properly fitting gun.

Other stock dimensions such as pitch and drop also have an effect on where the pattern will form. Comb and heel drop are vertical measurements in inches from an imaginary line running back from the top of the barrel to the top of the comb and the heel of the stock. These measurements are very important because they affect the vertical placement of the shot charge. A shotgun has no rear sight as a rifle does, so the eye's distance above the standing breech acts as a rear sight. A high comb positions the eye high and, just as raising a rear sight, gives a higher point of impact than a low comb. Drop at heel should be such that the stock fits comfortably in the shoulder pocket when the cheek is pressed comfortably against the comb at the desired height. American hunters do much of their shooting at flushing birds, so a fairly high comb is useful because it throws the pattern a bit high and thus lets them see a rising bird above the gun muzzle when the shot is fired, rather than having to blot it out.

I have a trap outfit that had a high thick comb. When I patterned it, the shot charge landed very high and a little to the left. A stockmaker friend lowered the comb little by little, taking a bit of the thickness at the same time. Eventually, he worked the comb to a point that the shot charge went just above the aiming point — perfect for the trap field. After I had the comb so "customized" for my face, I merely had to point and pull.

Pitch also influences the vertical placement of the shot charge. Pitch is the angle formed by the intersection of a continuation of the boreline with a straight line drawn through the heel and toe of the buttplate. In a sense, it tips the muzzle up or down. This can be demonstrated by standing the gun on its buttplate with the top of its action touching a vertical wall. The distance the muzzle is away from the wall, in inches, gives some idea of the pitch. This isn't an exact illustration as obviously the muzzle-to-wall distance will vary with the barrel length, but it allows comparison between guns of similar design and measurements. Pitch is usually "down," but it can be neutral or even up.

The Monte Carlo comb has long been popular with many trapshooters

Factory-length stocks are often too long for young shooters, can cause bad habits. When proper length is obtained, most other stock dimensions usually fall into place, though advanced shooters might insist on total customizing.

and is appearing on some custom stocked hunting guns. Monte Carlo is a term used to described a stock whose top line runs horizontal (parallel to the line of sight) from the nose comb to a point within a few inches of the heel; there it falls off abruptly to give the desired drop at heel. The design is more common on rifles, where it is often combined with a cheekpiece, as it gives better face support and eye alignment when using a scope. On a shotgun it has the advantage of keeping the eye at the same height above the rib regardless of which way the gun is swung. On a conventional stock, as the shooter swings left or right his face slides forward or back a bit on the comb, thus changing his elevation. The Monte Carlo prevents this.

A minute ago we mentioned that the eye should be looking straight down the rib when the gun is rapidly mounted. If it isn't the center of the pattern will go to the left or right of where it's wanted, depending upon the eye's lateral position, for just as the height of the eye governs vertical placement of the shot charge, its horizontal position governs what might be called windage. They eye's position in this regard depends upon the width of the face, the thickness of the comb, and the position of the centerline of the stock when viewed from above. Obviously, the width of the face varies among individuals and there's not much anyone can do about his own measurements here. But the stock can be designed to accommodate for this. When the stock is cheeked, the head is tilted to press the face down and across the comb as well as against the side of the stock, so the eye is not usually very far from the centerline of the rib. But it can be offset a bit. To overcome this, the stock can be "cast off" (cast on for a lefthander); that is, its vertical centerline is angled slightly away from the face, rather than continuing back in a straight line from the rib. This permits the eye to align perfectly with the rib and also moves the buttplate out a bit, which usually makes for a better fit in the shoulder pocket as wide shoulders tend to go with broad faces. Sometimes the toe of the stock is given a slight outward twist too, to get it away from the chest muscles and make a more natural and comfortable fit.

The old shoe that a shotgun stock shouldn't be altered as the gun will then be out of balance is pure hokum. I've been told, after suggesting to a customer that he have his stock shortened, that if the manufacturer had wanted it shorter, he would have made it that way in the first place. When, at a seminar on grouse shotguns, I suggested many hunters would shoot better with shorter stocks, one indignant owner of a Weatherby Orion over/under admitted the stock was too long for him. He even admitted he had problems with it in the field. But with fire in his eyes he said he would have to be out of his mind to cut if off and possibly ruin the entire shotgun. I was out of my mind for suggesting such a radical move, he added.

The Weatherby is truly a beautiful shotgun of high quality. But doesn't it seem ridiculous to handicap yourself by hunting with a shotgun that doesn't fit when the problem can be corrected at reasonable cost? Why not contact the manufacturer about the problem, or talk with a custom stockmaker about alterations? Just to accept that nothing can be done without destroying the beauty or balance of a shotgun, is about the same as not being able to see the woods for the trees.

Few of us will ever own a shotgun that is custom tailored for our body's specifications. Fortunately, today, a high percentage of shotguns have fine stocks as they come from the factories and, in their present configurations, are adequate for countless small game hunters. My gripe is that the rest of us are considered oddballs. I am happy to see that Remington offers a Model 870 youth outfit with a 12½-inch pull. Remington, Ruger and other manufacturers have gone pretty much to a 14-inch stock. That's a step in the right direction.

From what I have seen over the years, the basic problem with factory stocks is their length. Fortunately, this is easily corrected. When it is, the other dimensions are usually close enough that good shooting can be done.

The pistol grip on shotgun stocks is popular in America, due in part to our affection for pump shotguns. Almost all English stocks have a straight grip or hand. Since the shotgun was just an offspring of the black powder musket, it's understandable that American stocks show a good bit of rifle design. The stocks of yesteryear had excessive drop by current standards and were thin on the comb. The modern straight stock cuts down on recoil because the thrust comes back in a straighter direction, lessening the upward rotation which can hurt the face. A major step for the wingshooter was the development of the beavertail forearm. On old shotguns, the forearm was thin and short. The beavertail lets the left hand move farther out, making it easier to control the barrels while swinging on a target. The larger, thicker beavertail forearm has more gripping surface, allowing the left hand to

absorb more of the recoil, and it keeps the hand away from the barrels when they're hot.

How do you get a stock that fits you? Well, there are charts that explain this, and there are stockmakers who use a "try gun" — one with a fully adjustable stock — which shows the measurements you need. I'm not saying these approaches are wrong, but we go right back to the ambiguity of the term fit. Coming right down to the nitty gritty of all this, the only person who can tell when a stock fits is you. The next question tossed is, "How do I know when a stock fits me?" Even the stock-making experts don't completely agree on how and when a stock fits, and there probably is no set formula. Down through the years I established a few guidelines, and they work for me. Here's my formula: If you can reach the trigger without undue strain, see smack down the center of the full length of barrel when your face is firm on the stock, and if your shotgun comes up smoothly into the shoulder pocket and stays there when you are wearing a hunting coat or jacket, you are close to a perfect fit.

The hunter wants a shotgun that hits when the odds are against him. I know this to be true, since I'm a hunter. I do my shooting in weeds, brush and woodlots as well as fields. When game goes out, I have only several seconds at most to get the gun to my shoulder, point and fire. I may not have another opportunity to shoot the rest of the day. This is my moment, and I have to make the best of it. The shotgun and I must be compatible. If the stock is an inch too long, the comb a quarter-inch too high, or the recoil pad is thick and spongy, I'm already in trouble. The end result will likely be a miss. In a sense, I am to blame for using a shotgun that doesn't fit. A few dollars would have shortened the stock or replaced the recoil pad with a half-inch no-slip pad.

It's impossible to score every time, no matter how well the shotgun fits. On the other hand, it's a proven fact that the success ratio goes up when the shotgun fits. It's not logical to count the hours to the opening day of small game season and then hunt with a shotgun that handicaps you. Your hunting clothes fit, and so do your boots, driver's seat, eyeglasses, and about everything else you wear or work with. Why not be just as particular about your shotgun?

Shotgun Pointing

"DON'T AIM A shotgun — point it," is the sound advice given by many shotgun shooting experts. "Never aim a shotgun like a rifle," is another bit of supposedly sound advice from the sages of shotgun shooting. Let's go one more. "You must start behind the target and swing through it, touching off the shot the instant the muzzle passes its bill or nose." I must confess I have made that statement a number of times.

Ah, apply these words of wisdom in the field, and you will immediately step from sandlot shotgunning deep into the ranks of the experts. There's only one catch. Many of the top shotgunners I have hunted with seem to forget with surprising regularity their own words of advice. I helped one trap expert find 13 empties and two doves. Naturally, it was the worst shooting he had ever done, but I suspect it was the first time anyone stood beside him keeping score.

Since I'm already off on the wrong foot with some of my gunwriting contemporaries, let me admit I am an average shotgun shot and, much to the dismay of the experts, I favor what is called a "sustained" lead. I don't always swing through the target and fire, and I don't always pick a spot some distance in front of the moving target, wait until the target has reached a certain point, and then slap the trigger. No, I swing the muzzle in front of the moving target, estimate the proper distance, and while maintaining that lead, slap the trigger. Does it work every time? No, but it works better for me than any other method I have tried.

Too many factors are involved to make a definite statement that one kind of lead is better than another. When a rabbit is hightailing it through huckleberry bushes or green briars, I want to see any super shot take the proper lead. Brother, I just point out in front and fire, which, by the way, is known as "spot" shooting. That sneaky term comes from the fact that the

shooter picks a spot that he hopes his shot charge and the target will mate at. Believe it or not, I use a sustained lead on pheasant, which are normally shot out in the open, and a swing through on grouse. I have no idea how I developed this paradox in bird shooting.

It's rather plain to see that it is impossible to always use one sight picture. The situation itself governs a good bit how we fire a shotgun at moving game. My brother Cull was a methodical shot who had the swing through method down to perfection. He was exceptionally good on birds. Fred, on the other hand, shot the instant the butt pad hit his shoulder. He simply pointed and pulled. If Fred had a system, the rest of us never figured it out. Dan, due to health reasons and a weak left eye, was a bit slower and more prone to "rifle aiming." Right in my own family were the three different styles mentioned earlier. Each brother shot differently, but each had fair success on quail, rabbits and grouse.

This is far from conclusive proof that any system works, but I am willing to state that any system that works for you is the one to use.

I am guilty many times of rifle aiming. It just comes as natural to me with a shotgun as it does with rifles, which are my first love. "Whether it's wrong or right," as the old song goes, I close the left eye, aim down the barrel and shoot.

It could appear about now that I am not much of a teacher, when it comes to shooting a shotgun. I don't know about that as I'm pointing out that there is no one "absolute" way to shoot. Most of us tie the same type of knot in our boot laces, but watch ten hunters do it and you'll see some strange twists and turns. Yet the knot gets tied.

When I admitted that on some types of shot I shut the left eye and aim, I opened the door for the two-eyed shooter who will loudly condemn such action, claiming I am defeating one important reason both eyes are kept open in shotgunning — to improve the depth perception. I won't argue that. When one eye is closed, it is hard to properly estimate distance and speed. Undoubtedly, this holds true on long range shots, but it doesn't apply significantly in close range shooting.

There's an old saying that the master hand determines the master eye. In other words, if you are left-handed, your left eye will be the master eye or dominant eye, whichever sounds better. Again, I have to be one of the exceptions. I'm right-handed but have a master left eye. I don't know if that means when I close the left eye I'm closing my best one, but maybe it's true you can't teach an old dog new tricks.

Seriously, I close my left eye because it is the dominant eye, and my gun-writing friend Nick Sisley, who is a grouse and dove shooter par excellence,

has suggested doing this in several shotgun articles, rather than trying to become a left-handed shooter. I can offer some extra advice here. Instead of completely closing the master eye, squint it to cut down its dominating power. This way it still helps some with depth perception and field of view.

There are several methods for determining the dominant eye. One is to point directly at an object some yards distant with the arm and forefinger straight out and both eyes open. Close each eye alternately. When the master eye is open you'll continue to point directly at the object; when you close it and open the other, the finger will seem to jump to the side and will no longer be pointing at the object.

I mentioned that a shotgun should come to the shoulder in one fluid motion and nestle into the shoulder pocket, and that's true. The head should be fairly erect, and some shooters say they bring the shotgun up to the face instead of dropping the cheek to the comb. Maybe this works out in competition, but I never was able to do it under hunting conditions. I try to bring the shotgun to the same spot on the shoulder every time, and drop my cheek against the stock. It is imperative that your cheek should rest firmly against the comb. If you don't keep it there, you'll do more missing than hitting. Another point often overlooked is positioning the cheek at the same place on the stock for each shot, with the same pressure. If more or less pressure is used from shot to shot, it's about the same as adding cast off or on to the stock. It's similar to making a windage correction on a rifle sight.

A shotgun does not possess adjustable sights. This should be the first clue that a shotgun is not meant to be aimed. It's obvious that a rifle, with its single projectile, has to be accurately aimed for consistent hitting. The large expanding pattern of shot from a shotgun eliminates the need for sights. On top of that, who can precisely aim a shotgun in the brush?

I probably will escalate the adrenaline in a good many top shooters when I say that being a good shot does not necessarily make anyone a good teacher. Veteran shooters and hunters can often pass along useful advice to beginners, but in too many cases they insist on others doing everything exactly as they do it. That doesn't always work. First, each one of us has certain limitations. My brother Fred could shoulder his battered 16-gauge single barrel and fire in much less than two seconds. I saw him in action on dozens of small game hunts, and he often scored on seemingly impossible shots.

On the other side of the coin, Cull was a methodical shooter. He seemed to do everything by the numbers, and he was anything but quick. It always seemed to me that the rabbit or pheasant was getting out of range by the time Cull fired. That's how it appeared, but it was rarely the case. Both brothers had distinctly different shooting styles, yet both were fine field shots.

Not every one of us is capable of performing a given feat with the same dexterity as someone else. Fred's instinct was to shoot quickly; Cull insisted on taking plenty of time. Each was successful with the method he used, and both believed his system was the only way to shoot in the field. They were experienced hunters, for sure, but poor teachers because they refused to recognize there can be more than one way to get the job done.

After teaching dozens of people a few of the basic ingredients in good field shooting, I'm convinced that mastering the shotgun is a very personal matter. The method used is secondary. The shooter must see the target in relation to the muzzle. You can't point and blast. Whether you realize it or not, there has to be some correlation between the muzzle and the moving target. To make it easier to understand, the hunter has to know where his gun barrel is, in relation to the moving target, when he slaps the trigger. Some top shots say they do this automatically. I can't. I use the sustained lead, keep the gun swinging, and fire when the sight picture appears to be right. The faster the target is moving, the faster I have to swing. But I always see my target and the muzzle when I let the shot go.

With urbanization cutting into hunting lands and small game species dwindling in many areas, the shotgun hunter will have to substitute clay targets for real ones in practice sessions. In the golden era of hunting, rabbits, grouse, quail and waterfowl were so plentiful a hunter could work out his shooting problems right on the hunt. Not today.

Many shotgunners have a certain disdain for claybird shooting, but they have no viable grounds for their prejudices. The old cry that a claybird is nothing like a rooster coming out of the corn or a rabbit streaking out of a brushpile is not a fair argument. In fact, I never heard anyone say there is any similarity. Yet, a summer of trap or skeet shooting will make any hunter a better field shot. Don't be lulled into believing that claybird shooting has no relationship with field shooting. It's possible to learn more about swing, lead and follow through in two weeks of trap or skeet shooting than in two years of hunting.

I prefer practicing on a regular trap field, but plenty can be learned from using a Trius trap. The claybird can be placed on the throwing arm to sail at the angles the shooter finds the most difficult to hit. The cost is small compared to the benefits.

Grouse in thick cover are one of a shotgunner's toughest targets. A properly fitting shotgun that points without conscious effort — such as George Bird Evans' Purdey — is a treasure.

Even the most skilled coach can help only so much. In the end, each of us has to deal with his own physical makeup, temperament and reflexes. From a psychological viewpoint, each of us sees shotgun shooting in a different perspective. The answer is not necessarily in styles or methods, but more in honing our own skills in regulated practice sessions. Note, that I used the word "regulated." Practicing with a shotgun is not blasting tin cans out of the air; a more meaningful approach is required. Take the claybird route, for two reasons. You'll get sound tips from veteran shooters, and you'll get enough shooting to produce concrete results. When your average score goes from 10 to 16 clays out of 25, the picture starts to brighten. By the time your average is 19, you're on your way. How far you take it from there is up to you. But once you've reached this level, you'll find most live birds much easier than formerly.

To never miss is impossible and undesirable. It's the misses that make us want to do better. It's the misses that keep us interested in hunting. All the unexplained misses torment us during the idle periods between seasons. Frustrating as they are, they are essential. If we really became a never-miss shooter, we would be essentially computerized shooting machines. There would be no thrills or excitement, no personal challenge. We would die on the vine, so to speak. I don't have to worry about never missing; my concern is connecting on a reasonable basis. Sure, it's embarrassing to miss. I know about that, too.

On a pheasant hunt with three top shotgunners, including nationally known outdoor writer Gene Hill, I missed a rooster three shots "curving right with my swing." Red in the face? Embarrassed? You bet. I suffered all those things and more as the rooster sailed off into a weed patch. Two minutes later, Hill missed a rooster two shots, going straight away. Now, Gene Hill never missed a rooster twice on a straightaway shot. I'll always believe he did it just for me. He understood my embarrassment.

Learning to shoot a shotgun requires shooting a shotgun. That statement, which can seem either perfectly simple or highly ambiguous, is true. Experts can help you over the rough spots and point out glaring errors in your style but, in the ultimate end, you must be your own teacher. I reiterate that your best approach is via the trap or skeet field.

The ingredients for good shotgunning in the field are simple: Use a shotgun that has the right length stock; bring the shotgun up in a fluid motion; nestle it into the shoulder pocket; swing from the hips, and slap the trigger when your lead is right. This simple explanation is filled with a multitude or complexities that only you can solve. There's nothing more that I can do except encourage you to start now.

Rifled Slugs and Buckshot

GENERATIONS AGO, IN an attempt to make the shotgun suitable for big game shooting, at least at close range, ammunition makers produced shells utilizing a single round projectile loaded to somewhat higher velocity than a shot charge. Made of pure lead, the ball had the weight and diameter to kill many species of big game — provided it could be placed in the chest area. Such projectiles somehow acquired the monicker "punkin' ball," and are still referred to by that term, though I don't think they've been commercially available in this country since World War II days.

Punkin' balls were never known for accuracy; in fact, I don't think they could be relied on to reliably hit a whitetail at 35 yards. A big problem was the fact that due to the solidity of the spherical ball, its diameter had to be kept smaller than bore diameter to avoid possible damage when it hit the choke. In *Cartridges of the World,* Frank Barnes indicates balls a full gauge smaller than the shell were normally loaded — a 20-gauge ball in a 16-gauge gun, for instance, which would have been some .047 undersize. Obviously, little accuracy could be expected from such a combination. This practice probably led to the still-common belief that rifled slugs might cause problems in choked shotgun barrels, but that's not the case. American Foster-type slugs are not solid balls; they have a deep hollow base which easily compresses as the slug passes through the choke.

I never hunted with a punkin' ball — in fact, I can't recall that I ever shot any. I do remember watching a group of older hunters, back in the 1930s, firing several brands out of three or four shotguns, prior to deer season. It's impossible to remember the exact results now, but I do know there was a consensus that the punkin' ball could not be counted on even at close range.

Probably I was still subconsciously aware of that long-ago punkin' ball shoot when I started to do a series of tests with rifled slugs in 1970, as I still

With a low power scope installed in Kwik Mounts, 12-ga. 870 Remington with 20-inch slug barrel is deadly on many species of big game at woods ranges.

felt that slugs were inaccurate. I had to change my mind, as that testing, plus occasional tests run by myself and friends in the years since, showed today's rifled slugs can be effective at woods ranges in the proper guns.

In the early days, a significant problem in addition to the round ball's small diameter was the fact that many were used in double barrel guns, usually side-by-sides. These tend to cross fire. Over/unders generally group somewhat better, but any two barrel gun gives a built-in problem that a slug shooter is better off without. Single barrel repeaters such as the slide actions and autoloaders so popular with small game hunters do reasonably well with rifled slugs, though a problem here is the lack of adjustable sights needed to properly zero in. Once in awhile a gun will be found which will deliver slugs to point of aim at 50 yards or so when using only the front bead of the smoothbore barrel, but that's pure luck. Testfiring is the only way to check this out.

Anyone who is required by circumstances or law to use a shotgun with slugs for big game should consider buying one with a barrel that's dimensioned (and sometimes rifled) for today's commercial single-projectile loads. Numerous models are available, including the Beretta A303, BRI/ Benelli 123-SL-80 and Special, Browning Buck Special, B80 and BPS, Fie/ Franchi, Ithaca 87 and Deerslayer II, Mossberg 500, Remington 870, 1100 and 11-87, SKB 1300, Weatherby Eighty-Two, and Winchester Ranger and 1300. These are all autoloaders or slide actions. These barrels are shorter than standard smoothbores — usually in the 18½ to 24-inch bracket — and have little or no choke constriction. Most are available as replacements, which means it isn't necessary to buy a complete gun. They also serve well for a good percentage of upland hunting, providing patterns which handle pheasants, grouse, rabbits, etc., to 30 yards or so. This is an aspect which doesn't seem to get mentioned much, but considerable shooting indicates it's so. Therefore, an upland hunter who needs a new gun might consider getting one of these slug-barreled outfits for both small and big game. Most are offered with adjustable rifle-type open sights.

For the more serious slug shooter, several shotgun manufacturers now offer models with rifled barrels. There is some question about the legality of these in states which specify "smoothbore" guns for use on big game. Where such regulations are no problem, such a barrel could well be the optimum for the slug user. The Hastings Company of Clay Center, Kansas, has for some years been offering rifled replacement barrels for popular slide action and autoloading shotguns, and I wouldn't be surprised if this isn't what prompted the factories to edge into this field. No matter what the reason, hunters now have a good choice of slug guns or can create one by using their 870 Remington or whatever as a basis. Speaking of Remington, in early 1989 they announced that a new version of their Rem-Choke, usable with many of their popular single barrel smoothbores, would have a rifled tube for slug use. I haven't had a chance to use one as of this writing, but expect it will help. It will provide only a few inches of rifling, but that's about as much as used in the Paradox guns of long ago when British gunmakers tried to adapt smoothbores to slug use for emergency African shooting.

In response to the interest and improvements in slug guns, several manufacturers have come up with good systems for mounting scopes on them. Currently, two methods are used. B-Square, Kwik Mount, Weaver/Omark and probably others have units which are secured to the action by two pins which replace those that normally hold the trigger unit. These are essentially bases or wrap-around saddles which accept mounting rings on the top surface. They position the scope much as it would be on a rifle, so will handle most any conventional model. The second design utilizes blocks on the barrel, which puts the scope ahead of the action and thus requires long eye relief models such as those created for handgun use. A recent Remington barrel features a cantilever-type base which will accept either conventional or long eye relief scopes.

A slug gun is a short range proposition, compared to a high velocity rifle, so is best served by a low power scope. High magnification isn't needed for big targets at close range, but a large field and bright optics are important in the woods. That means a 2½x or 3x should be the normal choice, though perhaps a 1½-4½x would be even better. This small variable has an extremely large field at bottom power, for fast use on deer and bear in the brush, and plenty of power at the top end for the rare chance at longer range or for carefully aiming at an animal when only a small portion of it is visible. With a scope mounted, a slug gun zeroed at 100 yards will be only a couple of inches high at 50, which means it will handle most woods shots without having to guess at or compensate for trajectory. Some slug guns will group well enough to make them effective on deer and bear to 125 yards or so, but

this can be determined only by testing an individual gun. Different makes of slugs should be tried, as they don't all group equally well from a given gun.

Several styles of slugs are readily available. The American or Foster type, which made its appearance about 1936, is doubtless the best known in this country. I understand it was developed or designed by a man named Foster, but have no good source for that. Regardless, it's available from all the major ammo manufacturers in all common gauges — even the 410 bore, though its purpose here is beyond me. It is listed at 1/5 ounce in the 410, which is about 87 grains. That certainly is not enough to be remotely reliable on big game. At the other end of the line is the 10-gauge's 1 3/4-ounce slug. In 12-gauge, 1 ounce is standard and a 1 1/4-ounce version is available from Federal. Weight in 16-gauge is listed at 4/5 ounce, and 3/4 ounce in the 20. Velocities run from about 1280 fps with the 10-gauge to 1750 in a max-loaded 3-inch 12-gauge Magnum. Most are probably in the 1400-1500 fps bracket. As noted, this is fast enough to give slugs acceptable trajectory over 100 yards or a bit more, and the large diameter and heavy weight make them killers on the smaller big game.

American slugs from different manufacturers differ in specific dimensions despite their similarity in diameter and weight. All are soft lead cylinders having a round nose, hollow base, and vanes around the perimeter of the straight sides. I suppose the vanes are intended to cause rotation as the slug passes through the air, but I don't know if this occurs — or if so, if it's rapid enough to help stabilize the slug in flight. Chances are that's unnecessary anyway, as the heavy nose and hollow base produce a weight distribution that keeps the slug nose forward.

A recent development in this country has been the BRI slug, a 50-caliber wasp-waisted unit enclosed in a two-piece plastic sabot which is shed shortly after it leaves the muzzle. The BRI is currently made in 12-gauge only. It weighs abut 440 grains, which is almost exactly an ounce, and is comparatively solid in construction, so perhaps should not be used in barrels having tight chokes. A friend who has done a log of slug testing tells me that the BRI in a Hastings rifled barrel has given him the best and most consistent groups he's had from slugs, such as 1 1/2 inches at 50 yards and 4 inches at 100, using a low power scope.

On a worldwide basis, the Brenneke slug is probably better known than the American style. The Brenneke is a blunt-nosed lead cylinder with vanes around the circumference and a screw-attached felt base wad. In was developed in Germany near the end of the last century. Variations of it have been made in Austria, Belgium, Spain and elsewhere. One such example is the American 1.3-ounce (580 grain) Vitt/Boos, made for handloaders.

European versions weigh from 1 to 1¼ ounces in 12-gauge. Factory loads are said to give velocities of over 1500 fps. Brenneke slugs are also made in 16 and 20.

My shooting tests brought new respect for the big chunk of lead. The targets are long gone, but my records show that I fired numerous 5-shot groups under 5 inches at 50 yards, using only the front bead sight on an open-bored barrel. It became evident that slugs were easily capable of staying under 5 inches at 50 yards when using barrels designed for their use.

Later in the tests, I drilled and tapped a Remington Model 870 slug outfit (no special mounts were then available) and installed a Weaver 2-7x scope. This was a step in the right direction, and a photo shows that my first group was 3 inches center to center. Literally all of the 5-shot groups stayed under 3½ inches from the scoped Remington. Our oldest son, Darrel, fired one 2-inch group from the 870 pump with Remington Express slugs. When I saw the differences in groups sizes between conventionally sighted shotguns and the scoped Remington, I was convinced much of the inaccuracy with slugs stemmed from the lack of a good sighting arrangement. Today's special slug outfits are equipped with rifle type open sights but a scope is far better. My next preference would be a good receiver sight with a large aperture, such as the Williams Fool Proof, installed on the action close to the eye, with a white front bead at the muzzle.

As urbanization creeps outward farther and farther from the cities, hunters in many congested areas will be limited to slugs or buckshot. The comparatively short range of a rifled slug and its quick velocity loss make it acceptable in areas where rifle bullets might cause problems. Most of the grumbling about them comes from hunters who still compare rifled slugs with the long gone punkin' ball. That's about the same as comparing apples with oranges. Believe me, they

These 6 slugs were fired at 50 yards with an SKB over-under, the upper 3 from the modified barrel, the lower 3 from the IC. Many doubles, particularly side-by-sides, won't group this well.

are far apart in the accuracy column. I'm a rifleman and I don't look forward to using slugs, but I wouldn't stop hunting if I had to go to a slug outfit. The picture is not that dim. With the accuracy obtained from today's slug barrels, and especially from barrels with rifling, the effective range on deer with shotgun slugs is at least 100 yards, perhaps 125, especially if a good low-power telescope is mounted and zeroed in.

Buckshot is a different ball game. It is used extensively in many states, but it leaves a lot to be desired in the matter of effective range. Several years ago I hunted deer in the swamps of South Carolina, where only buckshot was legal. The only buck I saw was about 75 yards away. I watched in dismay as he ambled across a wide powerline right of way. It would have been meat on the table with almost any centerfire rifle, but all I could do was look helplessly at my 20-gauge double barrel.

I've read that 00 (double-ought) buckshot is effective on deer to 50 yards or more, but there's plenty of room for argument about that. Personally, I don't think the claim is true. I'm reasonably sure that if a 00 pellet, which is roughly 1/3 inch in diameter and weighs about 55 grains, hit a deer on the spine, neck or brain area of the head, a kill at 60 yards is possible, but as there is little semblance of pattern density at that distance with 00 buckshot, the shooter is banking entirely on luck. There are only nine 00 balls in the 2¾-inch 12-gauge Magnum and 15 in the 3-inch Magnum. Obtaining a suitably dense pattern beyond short range with even 15 balls is not easy and, as the yardage is piled on, it becomes next to impossible.

To compound matters, a buckshot ball can't be guided to an exact aiming point. There's no assurance of where buckshot will strike. During my 50-yard range tests, one or two balls usually struck the 4-inch bullseye or close to it, but that's not much of a testimony. At distances much beyond 35 yards, there is little chance of getting a dense pattern. On deer, the hunter must have multiple hits in a fatal area, even with 00 buckshot. Pattern efficiency was much better at 25 yards than at 40 or 50 yards. I got the following number of hits on a foot-square paper. They speak for themselves.

At 20 yards, 11 maximum, 8 minimum; 30 yards, 9 and 6; 40 yards, 7 and 4; 50 yards, 4 and 2. I'm not suggesting these results are absolute; they can vary significantly from shot to shot. But I sincerely believe they cast doubt on the belief that buckshot regularly produces killing patterns much beyond 25 yards.

Good advice to the buckshot hunter is to learn how your shotgun performs with a given load, and don't shoot farther than you can expect a killing pattern. Used properly, buckshot is effective, but the hunter must use good judgement at all times. It gives no room for error.

Handgun Basics

THE HISTORY OF the handgun dates back to the discovery that a mixture of charcoal, saltpeter and sulfur (black powder) could be used in arms much smaller than the big pots or vases used by the military. That type of handgun is far from the ones we are familiar with. It was essentially a small hand-held cannon. Still, something smaller was needed, and that is why the pistol with two, three or four barrels was invented.

In the early 1400s, multi-barreled handguns came on the scene. By the end of the 1700s, one style of multi-barreled handgun was called a "duckfoot pistol" because numerous barrels fanned out from a common center. This made what seemed to be a formidable weapon for use against mobs as the projectiles spread out over quite an area in front of the shooter. But, its limited use plus the built-in problem of misfires kept the duckfoot from generating a large following.

The multi-barreled handgun has not died. Around 1982, I tested a modern 4-barrel handgun. While it appeared to be well made, it did not function properly. Several times it failed to fire through its 4-barrel sequence, and I even had a hangfire.

Firearms history reveals that numerous models of multi-barreled handguns have been on the market at one time or another. Around 1858, Christian Sharps patented a 4-barrel outfit which sold well over 100,000 during the years of its production. Firepower was on the minds of handgun builders back then, and shortly after the Civil War, the harmonica pistol saw the light of day. Instead of having a revolving cylinder, as we know it today, the harmonica pinfire pistol had a sliding horizontal block with a series of chambers. From what I can gather, the block was moved one chamber at a time under the hammer, until all chambers had been fired.

Remington's Double Derringer was introduced in 1866 and continued in

production until 1935. This 2-barrel over/under was quite a favorite of the ladies, but I wonder what type of recoil this tiny 41-caliber handgun produced.

We think of revolving guns as being handguns but, long before the revolver appeared, revolving guns were on the scene. Basically, the revolving firearm of the 1500s utilized revolving barrels. James Puckle invented a single barrel monster that had a rotating cylinder, and in the early 1800s a Captain Artemus Wheeler, from Massachusetts, hit on the idea of a revolving flintlock handgun. His idea fell on deaf ears and all that remains of the Wheeler revolver are several museum specimens.

Even though Wheeler's flintlock revolver didn't survive, his idea did. No longer would the handgun be a cumbersome multi-barreled or sliding sleeve affair; the revolver would write a new page in American history.

The small hand-held firearm wasn't winning many converts prior to its adoption by the military. Colt's 1836 Paterson model didn't affect the popularity of the pepperbox design where instead of a cylinder the barrels rotated, and Colt was about ready to throw in the towel. However, fate intervened. The compact sidearm found favor on the western frontier. Such a gun had distinct advantages for horseman, especially in a running firefight with robbers or Indians. The Mexican War forced the military to put the stamp of approval on the revolver.

The Texas Rangers were involved, and many of them were carrying Colts. Their enthusiasm for this weapon motivated the military to take a second look at the revolver, and Captain Samuel H. Walker was sent to Colt to persuade him to turn out a bigger and more powerful percussion revolver. Walker was instrumental in inducing Colt to continue in business, and Walker also contributed to the design of the gun that would be known as the "Walker" Colt. It was a hefty outfit, tipping the scales at just over 4 pounds and running close to 16 inches in length. The Walker Colt definitely proved the value of the handgun, and the United States became the first nation in the world to issue a revolver to its troops. This move also established the revolver as a viable weapon.

From that point on, the handgun went through many stages of development. It cut a name for itself in American history, from the days of saloon shootouts of the Wild West to the national matches where the best target shooters in the world compete, to the prestigious Bianchi Cup where "combat shooters" put on incredible performances. During the course of history, the handgun has played many roles, but, today, a lot of emphasis is being placed on the revolver as a hunting gun, and this brings us back to the hunter and the handgun.

Despite the fact that the handgun is popular around the nation with both target competitors and hunters, among general shooters there is a misunderstanding about its nomenclature. The term handgun covers all types of pistols, revolvers and semiautomatics. At the start, they were all called pistols. Today, it's technically correct to refer to a semiautomatic or a single shot as a pistol. The term revolver is self explanatory; it means the type of handgun which has a revolving cylinder to hold the cartridges. Revolvers come in single action or double action designs. The single action requires cocking the hammer manually before each shot. The double action can be cocked manually or it can be fired by just pulling the trigger. When the trigger is pulled on a double action outfit, or the hammer is cocked manually on a double or single action, the cylinder revolves to align a loaded chamber with the barrel.

The revolver's cartridges are contained in chambers in its cylinder. Six is the normal number of chambers in a centerfire revolver, though some lightweight models have five. Capacity goes as high as nine in some 22 rimfire revolvers, due to the smaller diameter and lower pressures of these cartridges. There is much folklore about the American "six-shooter," and the deeds performed with it have been glorified in prose and song.

There is a small controversy in the hunting ranks as to whether the single action or double acton revolver is the better hunting handgun. The double action has more appeal for many, as it represents firepower and speed. From the standpoint of good shooting, neither firepower nor speed is essential to the hunter. Actually, the single action handgun, or using the double action outfit in the single action mode, is a wiser choice. For one thing, it's far easier to shoot accurately in the single action mode as trigger movement is much shorter and lighter. Manually cocking the revolver before shooting also allows the hunter to concentrate on the sight picture while releasing the trigger. To me, the single action has a distinct edge for hunting.

The semiautomatic fires with each pull of the trigger. Cartridges are contained in a separate clip or magazine which usually fits inside the grip handle. When fired, an internal bolt is pushed back, extracting the empty which is ejected from the pistol at the end of the bolt throw. A heavy spring then pushes the bolt forward. On the way, it picks up a fresh round from the clip and feeds it into the chamber. The pistol can be fired at a rapid rate, and it takes but a few seconds to remove the empty clip and install a loaded one.

The transition from a rifle to a handgun is not instantaneous; it takes time, spelled with a capital "T". The big game hunter who has scored consistently in the deer or bear woods with a rifle is faced with an entirely different situation with a handgun. They are worlds apart when it comes to

shooting accurately. The handgun is simply much more difficult to master.

The physical makeup of the rifle aids the shooter in holding a steady sight picture, but the compact handgun is a horse of a different color. Even using a two-hand hold on sandbags won't make the new convert look like an expert. The switch to the handgun should be made in steps. It should take place over a period of time, since range practice is the only way to become proficient with a handgun. Buying a 44 Magnum in November for use in December is not exactly the way to go.

To avoid a lot of pitfalls, the starting handgun should be a 22 rimfire. The Achilles' heel of the more powerful handgun cartridges is recoil and muzzle blast. The 41 and 44 Magnums can be fearsome. The convert to handgunning soon learns that these are tough babies to handle, especially with full power loads. Yet, the 44 Magnum is the one many new handgunners choose for big game hunting. From a ballistic standpoint, they have made the right choice; the 44 Magnum is a whale of a cartridge. But the 44 Magnum should be at the tail end of the switch instead of the first gun used.

My reason for suggesting that the novice begin his handgun career with the 22 rimfire is not because the ammo is less expensive. That's really not a valid reason. The bullet caster and lead scavenger can crank out top quality big bore loads for practically the price of the primer and powder. The paramount reason is psychological. The little rimfire doesn't belch, roar and kick like its bigger cousins. The 22 rimfire handgun can be mastered a lot quicker than a 357, 41 or 44 Magnum.

Much as in rifle shooting, the secret in handgunning is nothing more than concentration and the determination to keep practicing. This can be misleading. You may assume that I mean burning a lot of ammo at rolling cans, swinging blocks of wood or water-filled balloons. While there can be a

Howard Mortimer is one of many hunters who use handguns such as this scoped Thompson/Center 357 for woodchucks. They like the extra challenge such shooting brings.

lot of fun in this type of shooting, it does very little in the way of teaching the beginner how to handle a handgun properly. Handgun shooting should begin with paper targets, and it's wise to number and date each target. Keep them in proper sequence in a three-ring binder. They give a permanent record of results, and over a period of time will show your progress. It takes time to make the proper sight picture, breathing and grip consistent and automatic. Keep the yardage low. The idea is to become consistent.

When we talk about a lot of shooting, this shouldn't be construed to mean a hundred rounds a day. For the beginner, that's overdoing it, even with the common 22 rimfire handgun. Long practice sessions lead to fatigue, and fatigue leads to bad habits. It's wiser to fire two or three cylinders or clips of ammo, putting maximum concentration into each shot, than banging away two boxes to hear the noise, or in an attempt to hit a swinging block of wood or a rolling tin can. In the beginning, that is nothing more than a waste of good ammunition.

Before shooting, be sure you have the correct ammo and that you are wearing both ear and eye protectors. Don't permit anyone to stand or sit next to the bench or table you are shooting from. Start shooting at 10 to 15 yards. If you go for 50 or more, you will simply waste ammo, and you won't be able to tell if your sight picture is correct. Don't shoot at tin cans or pop bottle caps. Use a large paper target with a big bullseye. Use the standard sight picture with the top of the front sight just filling the rear sight notch. The top of the front sight should not protrude above the top of the rear sight. Cock the handgun, set the bullseye on top of the front sight at the 6 o'clock position, and gently press the trigger while holding the sight picture. Fire three shots. They should produce a cluster somewhere on the target. At first, don't be concerned about the size of the group, or even where the bullets impact on the target. Even at a short range, it's not unusual for a new handgunner to experience difficulty in getting a 5- or 6-inch group. It's more likely the first groups will run a foot or more, but that's nothing to get discouraged over. This is just the beginning, and there is plenty of time to work out the problems connected with everything from the grip to the sight picture.

There's no denying that a handgun is difficult to shoot accurately. I have always claimed that top handgunners are a breed of their own. It doesn't hurt to have strong hands, but the size of the hands and wrists will not make or break a handgunner. The way a handgun is held will. We have seen too much TV "never miss" handgun shooting. Shooting a handgun accurately is a science which must be learned by most shooters, and adapting your hand to the grip is of the utmost importance. In the beginning, you'll have to

deliberately place the handgun in the shooting hand. Practice with an empty handgun by pushing the grip hard into the V between your thumb and four fingers. While still pushing the grip firmly into the V, wrap your thumb and fingers around the grip.

This is a trial and error affair. The ultimate goal is to have a firm hold high on the grip with the first joint of the shooting finger comfortably against the trigger. The three fingers should be wrapped around the butt and the thumb should rest against the frame but have sufficient freedom to cock the hammer. To get the proper feel, the hammer should be cocked. On double action outfits, the trigger moves back considerably when the hammer is cocked.

Holding the handgun properly is to some extent an individual matter. Instructions by top experts may not work for you. However, it's imperative that you hold the handgun the same for each shot. If you cant a handgun, you'll get low and wide shots, just the same as with a rifle.

On the super magnums, it's advisable to use a two-hand hold. Wrap the nonshooting hand around the shooting hand for support. But be sure to keep the hand away from the cylinder as slivers of lead can be blown out of the cylinder gap as the bullet enters the bore. These tiny bits of lead can fly five feet or more and imbed into flesh. I know that to be a fact. I once fired a 22 H & R revolver at a rat eating at a pig trough. My father-in-law was at least five feet from me, but directly off to the side of the cylinder. I missed the rat, but my father-in-law calmly told me I had drawn blood — his. A tiny sliver of lead was imbedded in his face.

Flinching is common in all types of shooting, and even more so in handgunning. Big bore handguns crack very loudly and not too far from the ears, so it's imperative to wear plugs under ear protectors when firing the more powerful handguns. It's also vitally important to wear shooting glasses, and make certain that all close spectators are wearing both muffs and shooting glasses.

The shooter's psychological side takes over while the trigger is being pulled. Most of us have a tendency to hurry the shot to get it over with. This causes a flinch. You can check this for yourself by putting only five shots in a six-shooter's cylinder and allowing someone else to fire. Ten chances to one, you'll see a distinct flinch when the hammer falls on the empty chamber. There is no easy cure for this. It requires a lot of shooting, always concentrating on the same sight picture and trigger pull. Holding a steady sight picture through the trigger pull is of the utmost importance. It's not necessary to hit the bullseye every shot, but you want all the shots to form in a cluster. That proves you are using a consistent sight picture, and that you

are not flinching. A flinch will put that shot out of the cluster. Overcoming the tendency to flinch is a prime reason to start with the low-recoiling 22 rimfire handgun. Have faith; the flinch will eventually diminish, though it will probably have to be reckoned with again when a larger caliber handgun is used.

A handgun has a very short sighting plane. It's a scant few inches between the sights, even on a 6-inch barrel. It's best to hold a handgun at eye level so both sights can be easily and properly aligned.

Many times the hunter places the front sight on the target and overshoots because the rear sight is not brought up level. Holding the gun at eye level makes it easy to correct this. Whether is sounds reasonable or not, this sighting error is one of the most serious mistakes made by new handgunners.

The secret question that frustrates the new handgunner is a simple one. "What is accuracy with a handgun?" I've answered this question dozens of times over the years. Except for a few super gunners, accuracy with the handgun is nothing like accuracy with a competitive rifle. In fact, it's not close to the expected 100-yard accuracy with a big game rifle. Maybe I can call what we're talking about here "woods accuracy."

If you're dreaming in terms of minute-of-angle groups, you'd better stick with the rifle. Generally speaking, I believe that putting 5 shots in an 8-inch circle at 50 yards is excellent shooting with an open sight, out-of-the-box handgun. With a scope, the group size might fall to possibly half that size, but I am not discouraged when 5 shots land in a 5-inch bullseye from a scoped magnum. This type of accuracy will guarantee success in the big game woods. With the rifle, many shooters can meet these requirements at 50 yards from the offhand position. The handgun is a different matter, and the more powerful the handgun, the more difficult it is to master. This level of accuracy is certainly not the best a fine handgun will do in the hands of a top shooter, but it's a goal for the beginner to shoot for, and that's not a pun, either.

The handgun is a little like a friendly barking dog; its bark is worse than its bite. Its belch and roar can send fear and apprehension up and down the spine of even veteran handgunners. But even the mighty 44 Magnum can be tamed if the new handgunner is determined enough. Also, a muzzle brake can take a lot of the cantankerousness out of the magnum handgun.

The magnum handgun is powerful, I am not denying that. But I feel too many writers make too much of this power. I have seen articles suggesting that certain magnum handgun cartridges are capable of making clean kills far beyond 200 yards. I am opposed to such a suggestion. I'm well aware that a bullet fired from a 41 or 44 Magnum that hits the head, spine or neck of a

My son Tim uses a solid two-hand grip on Ruger Redhawk during an early session with the 44 Magnum load. Most handgunners use such a hold, or a rest, when hunting.

deer 250 yards away will in all likelihood be fatal. But such a hit is pure luck, and hunting should never depend on luck.

The most powerful handgun cartridge falls far short of equalling the power output of even the old 30-30 Winchester cartridge, and few big game hunters consider the 30-30 a 250-yard cartridge. I may offend a lot of handgunners, but I feel it's utter nonsense to even suggest using a handgun beyond approximately 100 yards. According to the latest *Hornady Handbook,* the 158-gr. semi-jacketed HP 357 slug can be given a muzzle velocity of 1250 fps. At 50 yards, it's still traveling at a brisk 1126 fps. However, at 100 yards it has fallen to 1035 fps, to 963 at 150, and to just under 900 fps at 200. Another 50 yards will erase another 59 fps. The energy figures show an even clearer picture of the 357's killing power — or lack of it — at long ranges. At the muzzle, the 158-gr. dishes out 548 foot pounds of energy. At a 100 yards, it is 376, and at 150, 325. By the time it reaches the 200-yard mark, energy is down to 283, and it drops to 248 fp at 250 yards.

The 44 Magnum fan feels his outfit is vastly superior to the smaller 357 Magnum. In truth, it is, but even the 44 Mag doesn't qualify as a 250-yard big game cartridge. The 44 Magnum 240-gr. HP bullet has a maximum velocity at the muzzle or just about 1300 fps. At 50 yards, it is still hitting 1169 fps, and this drops to 1071 at 100. At 250 yards, it is down to 873. Energy at the muzzle with the 240-gr. bullet is 901 foot pounds. At 50 yards, it's 729, and 611 at 100. It produces 528 at 150, 463 at 200, and 407 at 250 yards.

For comparison purposes, a look at the 170-gr. 30-30 shows it has a muzzle velocity of 2200 fps. At 100 yards, it reads out at 1825, and at 200 yards it's still moving at 1496 fps, which is almost 200 fps more than the 44 Magnum had at the muzzle. Energy at the muzzle is 1827 foot pounds, and 1257 at 100. It's 845 at 200, dropping to 687 at 250 yards. In other words, the 170-gr. 30-30 bullet has a greater energy output at 250 yards than does the 44 Magnum slug at 100. Here again, this is not a kick in the pants of the handgunning deer hunter, but my way of indicating it's unrealistic to think the magnum handgun cartridge generates dependable killing power much beyond 100 yards. I realize that a few experimenters, notably J. D. Jones and his cohorts, use extremely powerful custom made handguns, many of which are chambered for magnum rifle cartridges or equivalent wildcats, to kill even the largest African game. But I don't view these as true handguns. They're really short-barreled rifles and only a few super experts can control them, so we won't go discuss them here.

Which "normal" handgun cartridge is adequate for big game hunting is a highly controversial subject. Admirers of the 38 Special and the 357 Magnum claim either cartridge is adequate. The larger magnum users take a different attitude. Well, let's look at ballistics, and they more or less show that the 38 Special and the 357 Magnum both fall short. A lot of Pennsylvania handgunners use both cartridges for white-tailed deer, but success with them requires ultra - precise bullet placement. I'm aware that this will put me in deep trouble with the 357 Magnum crowd, but considering the limited power output of the 357 Magnum I feel it's really only common sense to stick with a 41 Magnum or larger. The larger bores offer ballistics more suited for big game hunting.

Becoming a competent handgun shot is a long and difficult process, but the rewards make the effort worthwhile. On top of the satisfaction of becoming proficient, handgun shooting can lead to other satisfying hobbies such as bullet swaging and casting. There is a sense of satisfaction in using your own bullets, and when a handgunner stands over his first deer taken with a homemade cast or swaged bullet he is bound to have a feeling of total commitment.

My final bit of advice is, if you get into handgun hunting, take it seriously; it's strictly for the dedicated.

The Flintlock Black Powder Outfit

WE MIGHT THINK the invention of the firearm was the end result of the military's search for a more effective anti-personnel weapon. After all, much of what we shoot today is directly related to some type of military involvement. For instance, the popular Winchester 308 cartridge is a commercial adaptation of the Army Ordnance T65 rifle and machine gun cartridge. Remington's 244 (now 6mm) is nothing more than the old 7x57 Mauser necked down to accept a 243-caliber bullet. The legendary 30-06, probably the world's most popular big game cartridge, was originally a military development. I could go on, but the point is made.

History does not — cannot — reveal any single name as the inventor of the firearm. As with the discovery of black powder, there is much confusion — many myths, falsified records and, in general, too many questions that defy answering. For you and me, this means very little. We wouldn't shoot any better or enjoy using firearms more if we had the inventor's name and address and knew what prompted him to design a gun. But to the firearm historian, the myths, half-truths and discrepancies, plus all the folklore surrounding the advent of the firearm, are pure delight. Tracing the history of a certain make or model back through the ages, with all the gaps and questionable records, would drive me up the wall, but not the historian. What to me would be dead ends to him are irresistible challenges.

Even a general account of the black powder firearm evolution, from the advent of black powder to the present day, is far beyond the scope of this work. However, since black powder guns, especially the flintlock rifle, are again an integral part of the Pennsylvania hunting scene, the use and care of the flint and frizzen rifle must be discussed a bit.

In another chapter various types of black powder guns were covered sufficiently to set the scene for the advent of the Pennsylvania long rifle,

erroneously called the Kentucky rifle. This misnomer has been firmly and everlastingly attached to the graceful long rifle of Pennsylvania, although its design and crafsmanship really had nothing to do with Kentucky. The long rifle's contribution to the settling of the wilderness known then as Kentucky was probably responsible for the new name.

The Pennsylvania long rifle is just another part of Americana; in the beginning it was the product of hundredes of German, Austrian, Swiss and French gunsmiths who emigrated to America to start a new life. They willingly packed their belongings, left their friends and relatives, and came to America. Most of these highly skilled smiths entered through the port of Philadelphia. That is why there is such a concentration of gunsmiths in the southeastern section of Pennsylvania, with more settling in the Lancaster area than any other part of the state. They brought with them gunsmithing skills they had learned as apprentices under very demanding masters.

The German Jaeger rifle also accompanied many emigrants. Basically a military firearm, the Jaeger was of large caliber, bulky and heavy, characteristics which didn't blend well with the needs of pioneers. Yet, the Jaeger is the direct progenitor of the Pennsylvania long rifle, which evolved over a considerable period of time, starting about 1728 and continuing long after the discovery of the percussion cap.

The Pennsylvania rifle was just as essential to the pioneer as the ax and the plow. As land was cleared and more people arrived, the trek to the uncharted wilderness known as Kentucky began. The name derives from an Indian word meaning "dark and bloody ground," because many Indian wars had been fought over this prime hunting region. When the pioneers moved into it, the Pennsylvania long rifle went with them.

Daniel Boone's tales of the rich soil and abundance of game beyond the Cumberland Gap enticed thousands to Kentucky. Thus the long rifle, made in Pennsylvania, lost its identity and has been known ever since as the Kentucky rifle.

The beautifully slender Pennsylvania long rifle has a nostalgic past, and figuratively touches every Pennsylvanian. Just a mile and a half from my home is the quiet village of Adrian, in Armstrong County. It was in this little railroad hamlet, in his father's blacksmith shop, that Chambers King started his famous rifle building career. I have often wondered, as I drove the unpaved streets of this small village which is sometimes called Gumtown, just where King's father's blacksmith shop was located. During my teenage years, I played baseball with the Adrian team, but I didn't realize then what an important contribution Adrian had made to firearms history.

King was a perfectionist, as shown by a story still told about him. He was

building a rifle for a man leaving for the Far West. The man had ordered the rifle well in advance of his departure date, and King worked on the rifle for months. But when the customer arrived to pick it up, King was not satisfied and had the man delay his trip for over a week while he refined it. King knew he would probably never see this customer again, but his passion for perfection was so great he wouldn't allow the rifle to leave his shop until it met his standards. This episode lends credence to the legends which have accumulated about the high quality of materials and the skilled workmanship that give the Pennsylvania long rifle its special niche in firearms history.

It's possible that a single shot from a Pennsylvania long rifle turned the tide of the Revolutionary War, and thus influenced the destiny of this nation. I'm referring, of course, to the legendary shot made by Tim Murphy, one of Colonel Daniel Morgan's company of Pennsylvania riflemen known as the Shirt Men. Murphy's shot killed General Simon Fraser, the commander of the British troops, in what was then known as the Second Battle of Freeman's Farm.

I have read several slightly different accounts of Murphy's shot, but it does appear he was using an over-under rifle made for him by John Golcher of Easton. The British, about 300 yards distant, were moving toward the Americans, and Morgan ordered a number of his men to climb some pines so they could get a better view and bring Fraser down. Murphy, along with other Shirt Men, followed Morgan's orders. Their rifles began to crack, but the general continued galloping his horse along the line of troops, shouting encouragement to his advancing men.

Murphy waited until Fraser was within 200 yards before cutting loose his first shot, which apparently hit the horse. Rotating the barrels he fired again, but his second shot failed to connect. He rapidly reloaded, while fellow Shirt Men's rifle balls whistled around the galloping gray horse. Still, the general was unscathed. Aiming carefully, Murphy's finger touched the set trigger for his third shot. General Faser stiffened, clutched his body, and slowly slid from his horse. He was fatally wounded, and his loss cost the British what history now calls the Battle of Saratoga. Many historians agree this was the turning point of the Revolutionary War, so it can be argued that Tim Murphy's shot with a Pennsylvania long rifle was the deciding action of those long and bloody years.

How much this episode has been embellished by time is unknown. Military records show that Tim Murphy was for real, a native of the Northumberland area, and that he did serve with Morgan's Pennsylvania Shirt Men. Possibly, time has enhanced the story of Murphy and his double-

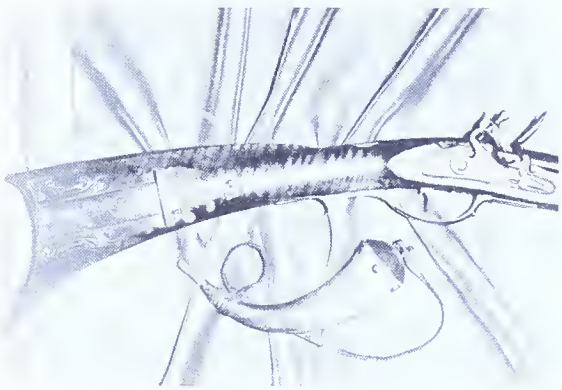
barrel Golcher — but on the other hand, maybe not. Regardless, a few lines from A.M. Sullivan's *Ballad of Tim Murphy* still conjure up unforgettable images of the Shirt Men and Murphy: "The redcoat and the redskin feared . . . The squinting eyes that looked along . . . The smoothbored rifles held by weird . . . Young woodland creatures with their long . . . Beards waving and locks unsheared . . . And one there was whose words made song . . . Tim Murphy with the gun by Golcher . . . Whose smoke was scented for the vulture . . ."

The more we know about the historical aspects of a favorite sport, the more enjoyable it is. Today, tens of thousands of Pennsylvania hunters are going primitive with modern versions of the flintlock rifle. There are several ways to obtain the flint, frizzen and steel rifle. A ready-to-go factory made rifle can be purchased at the local gun store, or a kit with all components included can be assembled. To some degree, the kit gives the builder an insight on how the flintlock is made, and creating a rifle from one can give a feeling of accomplishment. This is fine, and if done properly and all safety rules are taken into consideration, results can be rewarding. The kit can't truly be called a custom outfit, as it is assembled from ready-to-fit parts. Other than a minor bit of inletting and the external finishing, everything is done for the kit builder. That's not meant as criticism, but to point out that the pioneer gunsmith had more to contend with than just assembling parts. Let's take a look at barrel making to show what I mean.

Early black powder long guns were muskets. They had smooth bores. Cutting shallow grooves in the bore was at that time an unknown procedure. A smooth bore was not a bad design; in fact, it had several distinct advantages. The projectile — normally a lead ball — was made smaller than the bore, and so was easy to push through it. That almost had to be the case as many bores had a comparatively rough finish. Having a ball of small diameter expedited reloading, and it is said that a well-trained infantryman could fire three shots a minute from a smoothbore.

The smoothbore was also lighter and therefore easier to carry than a rifle because its barrel was thinner, a fact appreciated by the foot soldier. However, when it came to accuracy the smoothbore was not tackdriver. An enemy 150 yards away was usually safe. Even at 100 yards the smoothbore's accuracy was questionable. I might be going out on the proverbial limb, but I'd guess a shotgun firing even the old punkin' ball is probably more accurate than the smoothbore musket of the Revolutionary period.

The Jaeger, with its rifled bore, assured a higher degree of accuracy at long ranges than did the smoothbore, but hammering a lead ball through the bore with an iron rod, as sometimes was done with a Jaeger, deformed the



Thompson/Center flintlock, above, is a recent replica of an early Pennsylvania rifle; at left is another Pennsylvania Longrifle, built by J. Dickert of Lancaster, now enshrined in the Alamo.

ball and had a bad effect on accuracy. The Pennsylvania or Kentucky rifle, using a smaller-than-bore ball wrapped in a greased patch, not only reduced reloading time but also enhanced accuracy to a degree few had thought possible. The patched ball was a major step on the road to accuracy as we know it today.

Being able to place a bullet accurately at long distances made the long rifle an essential tool in the settling of America. The Pennsylvania rifle provided food for the table and defended the land. No other piece of equipment of that time played such a major role. The grooves in the bore certainly made a large contribution to the long rifle's effectiveness, but cutting them required great skill and an enormous amount of time.

Some years back, I had the opportunity to watch black powder barrels being rifled by the use of a button swage. With this method a carbide button is pushed or pulled through the bore. The button does not remove metal, it displaces it. The grooves on the button become the lands in the barrel, and the button's lands become the grooves. A helix governs the number of times the button revolves going through the bore. For instance, in a black powder rifle, the rate of twist might be one turn in 48 inches. In comparison, the twist in a high velocity centerfire rifle could be one turn in 10 inches. The faster twists rotate the long bullet faster, to give it more stabilization. The button method works under great stress, as it is displacing metal, but it takes only a few seconds to complete its journey through the bore.

It wasn't all that easy back in the days when a man by the name of

Schreckengost had a shop in Putneyville, Pennsylvania. A local historian told me the floor in front of the rifling setup had been repaired five times. Cutting rifling back then was quite a task. The gunsmith forced a long hickory rod, with a cutting head on the end of it, through the barrel. The rod slid through a jig to make the proper twist. When the knife would not cut a given groove any deeper, the gunsmith started another one. He kept this up until he had all the grooves cut to the depth of the cutter. Then he placed a piece of wheat straw under the cutter to raise it and started all over again. This continued until all of the grooves were cut to the proper depth. This would take several days or more, and required thousands of steps forcing the rod through the barrel and pulling it out. And the thousands of steps on the tiny bits of metal that fell on the floor wore out the boards in front of the rifling jig.

The exact caliber of a muzzleloading rifle was not too important. It could be anything from 40 to 45 caliber, or whatever. When the bore became pitted or worn from use, it normally was recut to a larger caliber. At the same time, the gunsmith would enlarge the owner's mould to make the proper ball size. Apparently, this could be done several times.

Although I have already written about black powder, I want to point out how it is sized. Kernel size is designated by the number of Fs. The F is usually followed by the letter "g," which means "glazed." Glazing comes from polishing the kernels in a revolving drum for several hours. This removes the rough spots and corners, giving the kernels a smooth, glazed surface. Graphite could be added to give a high polish to the kernels. Fg was very coarse cannon powder, FFg was used in shotguns, and FFFg, a very fine powder, was the most common propellant for early shooters. FFFFg was almost as fine as pepper and was used for priming flintlocks.

Black powder kernel size is determined by passing the powder through a series of screens, from large to small. From the hunter's standpoint, Fg is collected on the first screen which has 6 meshes per inch. FFFFg is the last screen, with 46 meshes per inch. The procedure is more detailed than stated here, but this gives some idea how black powder is sized.

Powder charges were sometimes said to be "one grain per caliber." Thus a 45-caliber rifle would use 45 grains of FFFg powder, a 50-caliber, 50 grains, etc. It is claimed that old-time shooters fired over a white sheet or snow to see how much unburned powder blew out of the barrel. The powder charged would be reduced until all the powder was consumed.

I'm not saying that method wasn't used, but I think it was flirting with danger. Don't try it with today's black powder. There's no truth that a muzzleloading rifle can't be blown asunder. The more black powder dumped

into the barrel, the higher the pressure. Normal black powder loads do produce lower pressures than smokeless (perhaps 7000 pounds per square inch in a flintlock compared to as much as 50,000+ psi in a centerfire rifle). Nevertheless, black powder does keep building pressure as a load is increased. There is no leveling off point, as is commonly believed. Long before it reaches its highest peak, an improperly tightened breech plug or one not tight against the counterbore could leak dangerously when subjected to beyond-normal pressure limits. Don't exceed the powder charges suggested in reloading manuals for your particular caliber.

When Pennsylvania initiated a special flintlock season in 1974, so the black powder buff would not have to compete against hunters with long-range, centerfire scoped rifles, it was generally thought the response would be minimal. At that time there were few black powder shooters and they tended to be congregated in certain sections of the state. These black powder fans who liked to dress in buckskins and carry hundred-year-old flintlocks and powder horns hardly made up a fraction of one percent of Pennsylvania's million-plus hunters. But the flintlock mania swept Pennsylvania like a prairie fire pushed by a high wind. Within a few years tens of thousands of flintlock rifles had been sold in the Keystone State, and by 1987 more than 75,000 were being used by deer hunters. It's possible there are more flintlocks in Pennsylvania now than in the 1800s.

There were not enough original flintlocks still in existence to satisfy the demand, so a number of gunmakers began producing ready-to-assemble kits so hunters could in a sense build their own. Some impressive rifles were created this way. However, I've heard of occasional problems with individual rifles. In some cases these might be dangerous. One that comes to mind is an inadequately tightened breech plug. Instructions with the kit should tell the amount of torque pounds necessary. They should also instruct the builder to make sure the lock is fitted flush against the barrel. There should be no visible gap between the barrel and the lock. One of Pennsylvania's finest black powder rifle builders, Lloyd Norris of Brackenridge, told me he machines the surfaces to make a perfect fit here. Where there is a gap between the barrel and the lock, it's possible for tiny amounts of the pepper-like FFFFg priming powder to get into the lock. If the lock isn't removed regularly for cleaning and oiling, this powder can accumulate and might be ignited by a spark or spurt of flame getting into the lock. This could endanger the shooter or bystanders, if the lock blew off. This is probably a remote possibility, but it can be eliminated by having a gunsmith correct the problem. However, it's still wise to remove the lock at the end of the day for inspection and cleaning.

Most flintlocks have a two-trigger firing arrangement called "double set triggers." The objective is to obtain an extremely light weight of pull, which many persons believe is an aid to accurate shooting. In function, pulling the rear trigger cocks or "sets" the front one. That is, it engages the front trigger with a series of levers. Only a few ounces of pressure will release the front trigger, and the levers multiply this force until enough is created to fire the rifle.

There are quite a few types of set triggers, but what I call the double action/double set is most common on flintlocks. With it a quick shot can be fired simply by pulling hard on the front trigger. A more precise shot can be taken after setting the rear trigger and firing the rifle by merely touching the front trigger. This works very well in competition, but more than one hunter fired his flintlock prematurely due to putting too much pressure on the front trigger before he had a steady sight picture. It can be exasperating.

I have had my share of problems with set triggers on both varmint and squirrel rifles. The set trigger is more complex than most single adjustable triggers. Sears that do not seat deeply enough in the tumbler notch may not hold the hammer after being cocked. Normally, when a set trigger begins to malfunction, it requires extensive repairs to make it safe. I'll be the first to admit that set triggers lend an air of originality to the flint and frizzen rifle but, from my point of view, they can't compare with today's adjustable single-stage types for hunting.

One disturbing feature on many set triggers is the loud "click" when the trigger is set. I've lost several shots at wary squirrels due to this. To compound the matter occasionally the chance for a shot is lost after the hammer is cocked and the trigger set, and many inexperienced shooters don't know how to get the hammer down without firing the rifle.

I suppose experienced flintlockers have developed various methods for dealing with this, but one method for uncocking the hammer is to push the frizzen to the upward position, dump the priming powder out of the pan, and release the front trigger while holding securely the hammer with the thumb. Carefully allow the hammer to go all the way down — not just to the first notch. Then pull the hammer back to the first notch, replace the priming powder and lower the frizzen. Practice this with an unloaded rifle to work out a smooth routine.

It's next to impossible to safely operate set triggers while wearing gloves as a friend found out a few seasons ago. He was offered a perfect 40-yard shot at a buck standing broadside. However, while removing his gloved finger from the trigger guard after pulling the rear trigger, he touched the front trigger. That small error ignominiously ended two hours of patient stalking

and the chance to take a nice deer. He still gets upset when he thinks about it.

Lloyd Norris was emphatic about the proper way to fill the priming pan. In fact, he claims the word "fill," in regard to the amount of powder needed in the priming pan, is wrong. He says it's unwise to fill the pan. Filling the pan causes several problems. First, excess powder on the lips of the priming pan prevents the frizzen from making metal to metal contact, which is needed for a tight seal. Secondly, as the rifle is carried in different positions, the extremely fine priming powder sometimes finds its way out of the pan, and the result can be hot sparks falling into an empty pan. Norris says it takes very little priming powder to ignite the main charge. He suggests filling the pan only to the bottom of the touchhole, never over or above it. Covering the touchhole with priming powder does not give a hotter flame, as many black powder shooters believe. It actually slows ignition.

A stumbling block that plagued flintlock builders for decades was getting the fire from the priming pan through the touchhole to the charge in the barrel. Enlarging the touchhole seems to be the answer, but an oversize touchhole allows powder to escape from the bore and, worse yet, the enlarged hole allows an excessive amount of hot gas to escape close to the shooter's face. That's not the answer, or the problem would have been taken care of long ago.

Originally, the length of the touchhole depended upon the thickness of the barrel wall. If the barrel wall was 1/4 inch thick, the touchhole was 1/4 inch long. The answer came in the form of a counterbored and threaded bushing. It has solved the problem.

With this system, a comparatively large hole is drilled through the barrel where the touchhole is going to be. It is threaded to accept a bushing which has a small hole drilled lengthwise through it and whose inner end is funneled out or counterbored to about half its length. When the main powder charge is dumped into the muzzle and settles in the chamber, some of it fills the counterbore. This reduces flame travel distance and makes ignition more positive. Another important benefit is the reduction of lag time between pan ignition and ignition of the main powder charge. Excessive lag time is the Achilles' heel for beginning flintlockers.

The flint and frizzen rifle has two different ignitions — one in the priming pan, the other when the main charge is set off in the bore. The period between the two is called "lag time," and it's unnerving, especially to new shooters. Learning to hold a rifle steady from the instant the flint smacks against the frizzen through the "swoosh" of burning pan powder and until the main charge is set off, takes some time to master. For the most part, the eruption of flame and smoke in the pan convinces many converts that the

shot has been fired. For a shooter to become proficient, it's mandatory to learn to "hold through" all this — which is another way of saying you must follow through. The face must remain on the stock and the sight picture must be maintained at all costs. This is a lot easier to say than to do but, once learned, exceptional results can be had with a flintlock.

Accuracy with the flintlock is not just a product of a perfect hold. That is a definite requirement for accuracy, but other factors that come into play with the black powder outfit do not get sufficient attention. Believe it or not, the method used for loading the flintlock will determine to some extent the accuracy of the rifle. How the patched ball is seated against the powder charge, and even placing the ball in the correct position, are other ingredients of flintlock accuracy.

Loading cannot be a haphazard affair. It it isn't done correctly, the flintlock will be erratic in its performance. Here is one method that has proven successful: Place the rifle on its butt with the muzzle away from the face and dump a measured charge of the correct grain size black powder into the barrel. Do not dump directly from a can or powder horn. A glowing grain of powder or patch thread from a previous shot could ignite the powder in the horn or can. Always use a separate powder measure. Be consistent in filling the measure. A small variation in powder charges might not be dangerous, but can play havoc with accuracy. After the charge has been dumped into the barrel, bump the lock areas of the rifle several times with

Black powder firearms lost their dominance about the turn of the century, but in recent years many hunters have returned to them, enjoying the aura they inevitably bring.

the heel of the hand. That settles the powder charge into the chamber and also into the counterbored section of the touchhole bushing.

Next, place a patch lubricated with a commercial lubricant, vaseline or cooking oil on the muzzle with the cloth's print or grain side up. Place a pure lead ball in the center of the patch with the sprue up. (The sprue is the flat mark made when the excess lead was cut from the ball in the mold. Some commerical balls are swaged and do not have a sprue mark.) With the stubby end of the short starter, shove the patch and ball into the muzzle. This requires some force, and it's not a bad idea to slap the short starter with the palm. This will seat the ball just into the bore. The excess cloth can be cut off with a sharp knife. Using the long end of the short starter, push the patched ball four or five inches into the muzzle, then use the ramrod to push it down firmly on the powder charge. It's imperative for the ball and patch to make firm contact with the powder charge. However, it is not necessary to pound on the rod — that does no good. If accuracy is expected, consistency is the name of the game when seating the ball. Try to load and seat each ball with the same pressure.

Once a ball is firmly seated on the powder charge you intend to stick with, draw a ring around the ramrod at the muzzle. On subsequent loadings, a glance will tell if the ball is on the powder charge. An air gap between the ball and powder charge is dangerous.

I've discussed the contributions made by the patch, but I would like to impress upon new black powder shooters that the patch is not just a wet piece of cloth that makes loading easier. Accuracy is directly related to the patch and how well it transfers the spin of the rifling to the ball. The ball is smaller than the bore, so it does not fill the grooves, as does a centerfire bullet. The patch is the filler between the ball and the bottom of the rifling. In a sense, it wedges the ball in the bore. It also acts as a seal to prevent gases from escaping around the ball and, to some extent, it probably keeps the bore from leading.

Proper patch thickness has to be determined for each rifle. The patch is subjected to a great amount of stress, so it has to be tough. That is why it's important to use bed ticking, denim or other durable fabrics. Hard fabrics such as denim should be washed several times before use to make them a bit more pliable. The patch/ball combination must make a good fit. It takes some experimenting to find this combination. Too thick a patch makes loading difficult, especially in a dirty bore, while a too-thin patch permits hot gases to escape around the projectile. Not only are pressure and velocity lost then, but the hot gases burn away parts of the patch, the wedge factor is gone, and accuracy deteriorates.

What took place as the ball passed through the bore is plainly written on the patch, which often can be found and examined after the shot is fired. Heavy black marks on the patch with clean spaces between show that the patch was riding on top of the lands. A proper fitting patch will also have heavy black marks but the spaces in between will be darkened with powder residue. This is definite proof the patch touched not only the lands (the heavy black marks), but also the grooves (the lighter marks between the heavy black marks).

Determining patch thickness is usually done by trial and error. One method that can help is to subtract the ball diameter from the groove diameter and divide that sum in half. For example, let's consider a 50-caliber ball. Its diameter must be smaller than the bore diameter. Ball diameter is easily measured with a micrometer. Say it measures .498. To obtain bore and groove diameter, an oversize pure lead ball can be shoved through the bore. Measurements than can be made of its bore and groove diameters. If the bore diameter is .502, say, and groove diameter measures out to .522, the ball will work perfectly. Subtract .498 from .522, which shows a difference of 24 thousandths of an inch. As the patch is on both sides of the bore, only half the difference is needed, so divide 24 by 2. This means the patch should be 12 thousandths of an inch thick. This is not an absolute answer, but it gives a starting point.

Slugging a bore is not difficult but, in the case of black powder rifles, it's best to have a gunsmith do it as removing and installing the breech plug with the proper torque poundage requires tools which the average shooter doesn't have.

For the flintlock deer hunter, going to all this trouble is probably a waste of time and money. A patch and ball combination that slides down the bore without excessive pressure is all that is necessary. Some shooters use a normal patch for the first shot, then switch to a thinner one for a quick follow up shot. The more fouling in the bore, the harder it is to reload in a hurry, especially with a thick patch. The patch separates from the ball shortly after leaving the muzzle, so a number of patches should be retrieved for examination and study. The markings on the fired patch can show if the correct thickness is being used.

A number of patch lubricants are on the market today, and it's fair to say most are safe to use. Choosing the best one is a matter of experimination. Although many black powder shooters believe saliva is the best, that is far from the truth. Saliva will rust and pit the bore, if used extensively. It should be used only in an emergency.

I have been asked why the flintlock has such a slow twist. It apparently

was learned shortly after rifling was developed, probably through trial and error, that a slow twist in a long barrel gave a round ball better accuracy than a fast twist. It wouldn't surprise me to learn that early gunsmiths also found it easier to put in slow twist, as this would require less effort. That's only an assumption.

A round ball is the smallest projectile that will completely fill the bore of a particular caliber. Yet a round ball has very little bearing surface, and its sectional density is low. Nothing smaller can be successfully used in that particular bore. In colonial days, little was known about physics or internal ballistics. There was no way the rpm's of the ball could be determined, nor even how fast it left the muzzle. We know now that the physics of the round ball demand a slow twist, but I doubt if Chambers King and his contemporaries fully understood, in a ballistic sense, why the slow twist worked better with the round ball better than a fast twist.

The exceptionally slow twist works well in long barrels, but in short-barreled handguns, a faster twist, say 1 turn in 20 inches, produces better accuracy.

Converts to the flint, frizzen and steel rifle often experience misfires. They shouldn't, but they do. A misfire is more than frustrating; it can be downright dangerous. If a black powder rifle misfires, keep the muzzle pointed in a safe direction and keep a tight grip on the rifle. Hold it in this position long enough to assure yourself that the possibility of a hangfire is past. Dampness in the main powder charge will sometime cause a hangfire. It may take several or more seconds for the powder to ignite and fire the rifle.

Keeping the muzzle pointed in a safe direction, examine the touchhole. It's wise to run a small wire through the hole into the powder charge in the bore. A plugged flash hole is the prime culprit most of the time. Reprime and try again. If the rifle still will not fire, place a few grains of priming powder in the touchhole, reprime the pan and touch off the shot. If this doesn't work, it might be necessary to have a gunsmith disassemble the rifle and remove the powder charge and patched ball.

Sometime during a flintlock hunter's career, a patched ball will be shoved into the bore before the powder charge is dumped. This might sound a little far-fetched, but countless gunsmiths in Pennsylvania get in one or two flintlocks each season with a ball in an uncharged bore. To correct this problem in the field, put a few grains of priming powder into the touchhole, prime the pan and fire the rifle in a safe direction. This tiny bit of powder will not force the ball through the bore, but it will move it far enough to allow more priming powder behind it. Work more powder through the flashhole, but this time seat the ball on top of the powder before firing. In most cases,

this will eject the ball. If this fails, a gunsmith can remove the ball with a special "worm" or by disassembling the rifle.

The flintlock is far from a perfect firearm, and it is plagued with problems from weather to misfires. The shooter must understand the chain of events that takes place from the time the trigger is released until the ball clears the muzzle. All the writing in the world will not teach a new shooter how to get the best from the flint and frizzen rifle, but controlled practice sessions will.

The solutions to all the problems discussed in this chapter can be better understood, and sometimes solved, by regular practice. Experience with the centerfire cartridge has made today's flintlock shooter careless. The centerfire rifle fires every time. In a lifetime of shooting, I have had no more than a half-dozen misfires with factory cartridges, and several of those probably were caused by my carelessness. I have had a few more than that with reloads but, here again, the fault was with me or the person who reloaded the cartridge. That's not the way it is with the flintlock. While the centerfire is well protected against outside elements, the flint and frizzen rifle is vulnerable to everything from wind to rain to careless loading techniques. Regular shooting brings these things to light.

My woodchuck hunting pal, Tom Leete of Coudersport, is a dedicated flintlocker. He shoots often. Tom's favorite method of hunting chucks is to walk slowly along the edge of a field. When an alerted chuck stands up perhaps a hundrd yards away, Tom checks the sight data chart taped to his stock, makes a minor rear sight correction if necessary, and removes the chuck with a well-placed offhand shot. He reloads in a matter of seconds, without using any of the quick-loading gadgets on the market. Everything is authentic with Tom, from the powder horn to the bed ticking.

The flintlock is a definite link with the past. It allows a hunter to walk in the moccasins of his forefathers. Yet many hunters want nothing to do with this design. This brings to mind the hunter who said, after having two flashes in the pan before the buck walked away, "If I'd had a real rifle, I'd have had a deer." That's an unfair assessment of the flint and frizzen rifle. Given half a chance, it is dependable and will perform to a high degree of efficiency. After all, it's been doing that for nearly 500 years.

Black Powder Percussion Outfits

THE FLINTLOCK IGNITION system was far superior to its predecessors, but it was far from trouble free. Even though the flint and steel system was the paramount ignition system for several centuries, the search for a more dependable way of igniting powder in the firearm barrel never ceased. The advent of the percussion cap ended the search for the ideal ignition system in the black powder, muzzleloading firearm. Before further refinements could be made on the percussion cap, the breechloader ushered in a new era. Yet, the percussion cap had its day of glory, too.

The flintlock and all its predecessors were plagued with ignition problems. Unless everything was right, the chance of a misfire was great. The percussion cap changed all this. Unlike the flint system, the percussion cap was essentially impervious to weather, improper loading procedures, and unexplainable pan fires that failed to ignite the main charge in the bore. On top of this, the percussion system offered faster lock time and did away with the annoying swooshing flame in the priming pan. Even the modern flintlocker knows how distracting the priming flame noise can be.

The wheellock was often referred to as the "gunsmith's delight," due to its complex system and numerous parts. Anything so complicated had to fail frequently. The flintlock isn't nearly as complicated as the wheellock, and the percussion cap isn't as complex as the flintlock. Yet a dull flint, worn frizzen or even a flint set at the wrong angle could make the flint ignition system fail. The caplock outfit has just three main parts in its ignition setup: the hammer, the nipple over which the percussion cap fits, and the cap itself.

It operates in a simple manner, too. After the powder and projectile are loaded, the hammer is cocked and a percussion cap is fitted over the nipple. There is a hole through the nipple into the powder chamber. The percussion cap is a thin, soft metal (usually copper) cup that contains a small amount of

fulminate (originally, fulminate of mercury). The hammer is carefully allowed to rest what is called "half cock." Half cock is normally a notch in the hammer, cut deeply enough so that the sear cannot be pushed out of it when pressure is applied against the trigger. In a sense, the half cock position acts as a safety.

To fire the caplock, the hammer is brought back to full cock and then released by pressing the trigger. The blow of the recessed hammer crushes the cap between the hammer and nipple, setting off the fulminate. A burst of flame goes through the hollow nipple and ignites the main charge in the bore. It's almost as foolproof as a centerfire primer.

It's wise not to immediately retract the hammer after firing. Its recessed face encloses the cap and prevents air going through the nipple into the bore. Sealing off the air helps smother any bits of burning powder left by the shot — a safety factor when the next powder charge is loaded.

The percussion cap should be a good "squeeze" fit around the nipple. If it isn't, a gentle squeeze on the flanges of the nipple will tighten it.

The percussion cap era was short-lived. It enjoyed a life span of around fifty years. However, before it was replaced with the self-contained metallic cartridge, thousands of rifles shotgun and handguns were built for the caplock.

The black powder shotgun never received the fame and glory heaped on the flintlock rifle and percussion handguns. It was not used in frontier wars or Indian battles, but it carved a notch in America's firearms history, and today many black powder fans religiously hunt with the percussion shotgun.

When purchasing an antique muzzleloading percussion shotgun, several steps are mandatory. First, have a gunsmith check it to determine the gauge. Many sizes which seem odd today were made, such as the English 14 gauge. Knowing the correct gauge gives a starting point for determining proper powder/shot combinations. The second step, which is even more important than knowing the gauge, is to make certain the shotgun is safe to shoot. Most old black powder shotgun barrels are made of Damascus twist steel, and will not withstand the high pressure generated by smokeless powder. Never fire smokeless powder in a black powder firearm. Don't dream up powder charges. Check a black powder reloading manual for charges for the gauge being used. Stick with moderate loads for small game hunting.

If you intend to take up the muzzleloading percussion or flintlock shotgun, your first move should be to join the National Muzzle Loading Rifle Association (NMLRA), P.O. Box 67, Friendship, Indiana. Its platform is the "understanding of an ability in marksmanship with early American muzzle loading firearms." Through this organization, a new member can

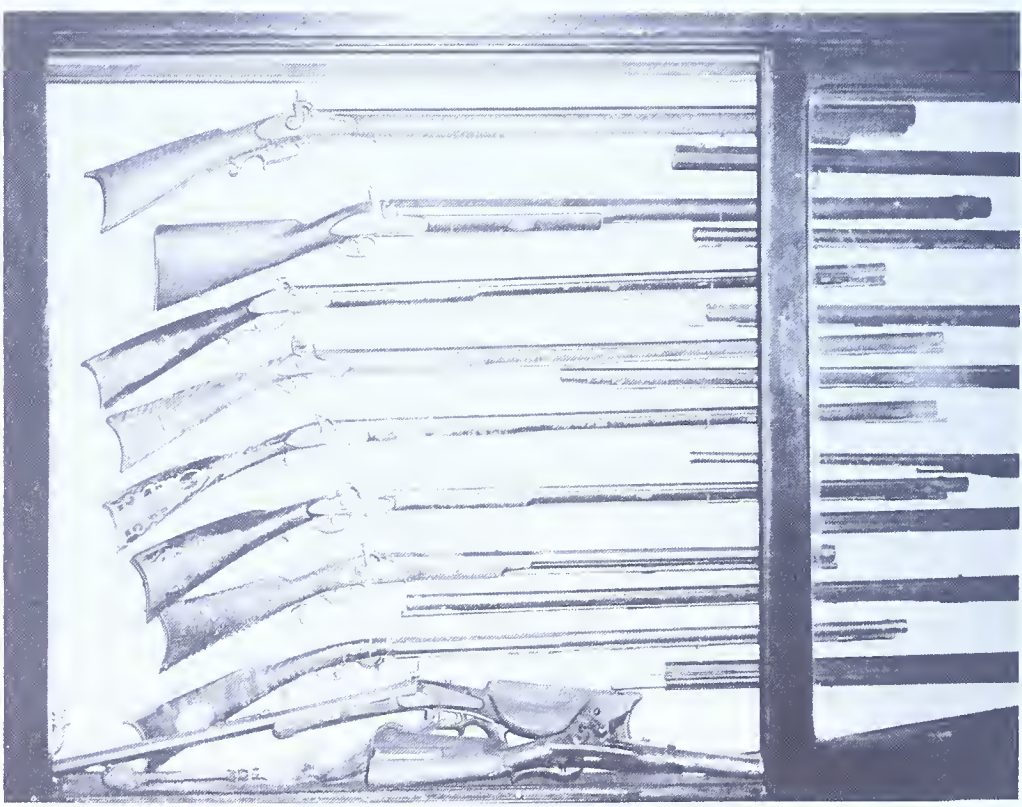
associate with experienced gunners who understand all aspects of black powder shooting.

The NMLRA puts out a monthly magazine, "Muzzle Blasts," which carries a lot of expertise on the use of black powder firearms and all dates of shoots and other state events. It will make a shooter's transition from smokeless to black powder a good deal easier, and that's more important than many shooters think.

It isn't fair to discuss the black powder muzzleloading rifle and shotgun without including something on the caplock revolver. Its lifespan was indeed only a few decades, yet it still has a tremendous appeal for the black powder crowd. Although there are still surviving examples from the post-Civil War period, many caplock revolvers on the scene today are of current manufacture and made of top quality steel, so will easily withstand the suggested loads in reloading manuals. Owners of authentic original caplock revolvers should not fire them until they are okayed by a good gunsmith.

Loading is not difficult. Make certain each chamber and nipple is clean and dry. Snap a cap or two on each nipple to make certain there is no dampness in the vent or chamber. If the nipple, chamber and barrel are dry,

This collection of black powder firearms includes both percussion and flintlock models, some intended for benchrest competition, others for hunting.



the pressure generated by an exploding cap will rustle dust or bits of paper near the muzzle.

The type of shooting to be done influences the loading of a cap and ball outfit. Not all of a revolver's chambers shoot with the same degree of accuracy. Some shooters test fire each chamber a number of times to find out which one gives the best results. In competition, that's the chamber they use.

Loading is merely a matter of holding the gun upright and pouring a measured charge into each cylinder. For competition, better accuracy will usually be obtained if the ball is seated almost flush with the end of the cylinder. The advantage here is that the ball does not have any significant distance to travel before it exits the chamber and enters the bore. However, it is very dangerous to have airspace between the powder and the ball. So you must add an acceptable filler, such as cornmeal, between the powder and the ball. Use enough to permit the ball to seat on the filler when just beneath the end of the cylinder, so it won't be sliced on the frame as the cylinder rotates. Don't be surprised at the use of cornmeal; I use it as a filler when fire forming some centerfire wildcat cartridges with small amounts of pistol powder. It's good for more than corn cakes.

The cap and ball loading procedure is a little different for hunters. Pour a measured charge into each chamber and seat the ball on the powder, sprue up. A seal and some type of lubricant is needed. This can be anything from Crisco to a commercial bullet lubricant. This not only helps lubricate the chamber and barrel, but also prevents the firing chamber from setting off the one on either side of it. Fill the space above the ball in each chamber with the lubricant and attach the caps. The cap and ball outfit is then ready for action.

If a misfire occurs, keep the muzzle pointed in a safe direction long enough to allow for a hangfire. Most black powder shooters hold aim for about thirty seconds, then move the hammer to halfcock and remove the spent cap. It's not a bad idea to run a wire into the nipple vent just to be sure it's clear. Recap and try again. If it still doesn't fire, remove the caps from the remaining nipples and take out the cylinder. Remove the nipple from the non-firing chamber, put in a few grains of fresh powder, assemble, recap and fire. If it's still dead, take the handgun to a gunsmith for removal of the charge.

When using black powder, it's mandatory to clean the firearm after every hunt or range session. The old-fashioned way to clean a muzzleloading rifle was to remove it from the stock, remove the threaded bushing on flintlocks or the nipple on percussion outfits, and put the breech end in bucket of extremely hot soapy water. Using a tight-fitting patch, the hot water was pumped in and out of the barrel until the patch came out clean. With this

method it's best to get the barrel as hot as possible, as that aids in drying.

After the barrel is thoroughly washed with the soapy water, rinse with very hot clean water and dry immediately with several patches. Then lightly oil the bore.

There isn't anything wrong with the hot water method, but several black powder bore cleaners now on the market make cleaning less of a chore. I have used with good success Hoppe's No. 9 Plus Black Solvent, and there are other commercial cleaners that will keep these outfits free of rust and pitting. The answer may be not so much what you use, but the fact that you religiously clean and oil your black powder gun. It's as simple as that.

I can't bring the black powder section to a close without mentioning a substitute powder that came into this area during the late 1970s. I'm talking about Pyrodex, of course. Pyrodex was born out of necessity. During the 1960s, when a good bit of unrest was sweeping across the nation, stringent controls were placed on a variety of propellants, especially black powder, which was erroneously thought to be the main explosive used by terrorists. These restrictions caused a speed up in efforts to find a substitute for black powder. This was not a new idea but, so long as black powder had been readily available, the push for a substitute was not great. The restrictions put a new emphasis on finding a substitute and, after much discussion and some experimenting, Dan Pawlak took up the task seriously.

Pawlak was an active shooter and handloader, and had an intense interest in explosives and pyrotechnics engineering. Many propellant manufacturers felt it was impossible to find a substitute for black powder, so Pawlak didn't get much encouragement. Naturally, he was aware of the previous failures, but his own formulas and tests convinced him that a powder could be manufactured which would give ballistic results similar to black powder and almost identical pressure/velocity figures.

The replica powder had to be less sensitive than black powder to heat, flame and shock and, above all else, have no likelihood of exploding. To add to Pawlak's problems, the end product had to be affordable to all black powder shooters. Attaining all this was a tremendous task.

After several years of experimenting Pawlak, along with several other dedicated people, developed a gray-type powder, but it lacked some of the characteristics necessary to make it a viable substitute. Nevertheless, he could see light at the end of the tunnel. Much of his experimenting had been done with his own money or contributions from helpers, but now that he felt he was finally on track, he sought the help of major arms manufacturers.

Little by little, the new grey product was changed to meet the strict requirements, including making it black to please the die-hard black powder

fan. The final test, of course, was to meet the strict government requirements.

Pyrodex passed all the tests, and it was concluded that the new replica powder was as safe, if not more so, than conventional smokeless powder, due to the fact that Pyrodex requires a higher ignition temperature.

Dan Pawlak made a major contribution to black powder shooters around the world. However, there is a tragic side to the story of Pyrodex. In 1977, Dan Pawlak and three employees died in a fire that swept the factory. Pyrodex is a lasting memorial to a young man who accomplished what some so-called experts said was impossible.

Today, Pyrodex is manufactured by the Hodgdon Powder Co. of Shawnee Mission, Kansas. The name Hodgdon is synonymous with powder. Hodgdon was first to market 4895, which is generally recognized as the most universal rifle powder available. Hodgdon was also first to market 4831, for many years the slowest commercially available powder, and thus the one that made many of the large capacity cases practical.

Every black powder gun has its own idiosyncrasies, and each will have to be dealt with separately. It requires extensive testing to obtain the best results from any black powder firearm. Accuracy depends a good bit on the fit of the patch and ball, as well as the powder type and charge. Many other variables are also involved in accuracy. Testing and keeping records is the best approach.

Much more could be written on various aspects of the black powder outfit, but that is not possible here. When we look back, we can see that by the late 1800s smokeless powder and the self-contained cartridge laid to rest the sulphur, charcoal and saltpeter firearm which had reigned supreme for nearly 500 years. Smokeless powder was vastly superior, and offered far more efficient cartridges and firearms.

I am not saying that the demise of the black era powder gave reason to rejoice. Its history was long and impressive. But time goes on and progress is made. Black powder with its hanging white smoke of battle and brimstone smell of sulphur had its day, but smokeless powder ushered in a new era. Still, nearly six centuries after its development, dedicated black powder fans keep the flame alive. I hope the scrape of flint against steel and the billowing clouds of pungent smoke will remain a part of the Pennsylvania hunting scene for generations to come.

Reloading

WE THINK OF home reloading as something relatively new. That is because it took the shooting fraternity by storm after World War II. By the mid-1950s, in some areas handloading was putting a serious dent in the sale of rifle cartridges. The owner of one sports shop told me he was getting rid of all reloading equipment because so many handloaders were selling reloads that he was afraid of being stuck with thousands of dollars worth of factory ammunition.

I thought that was a short-sighted view and suggested that he get more involved with handloading equipment and components. But he was only interested in selling factory fodder. He felt in time handloading would die a natural death because, in his opinion, a handloaded round was definitely inferior to a factory round. He stuck to his word, but handloading equipment kept right on selling in my area, and the sport store that sold "factory ammo only" died a natural death.

I think it's safe to say that reloading has been with us since the day of the first firearm. Now, I know the difference between reloading and handloading. The latter, in the purest sense, is using hand tools to fill an empty cartridge case with the proper components. Reloading, on the other hand, is putting an unfired cartridge, or components, into the chamber or barrel of a firearm after a given shot is fired. The shooter of the 1300s who fired the pot-de-fer, as the French called it, loaded his pot or vase with black powder and some type of projectile which could have been anything from a metal ball to a large arrow made of iron, including the feathers. And just a few minutes before writing this I reloaded a M700 Remington 7mm Magnum with a handloaded cartridge. Technically, that's the difference — you reload a firearm, handload a fired case. But today's shooters often use the terms interchangeably.

Handloading, as we do it today, has been around since the 1800s. Gun catalogs from the turn of the century show that some very sophisticated reloading machines were available to the shooting public. Let's consider the Ideal Loading Machine, shown in a 1903 catalog of the A. J. Rummel Arms Co. The catalog states unequivocally that the Ideal Loader is "the handiest, lightest and best machine in the field." I take it from that statement that other reloaders must have been available at that time. It goes on to say that the Ideal Loader handles nitro as well as black powder, and a rifle shell as well as a shotgun shell. It was guaranteed to load grains as well as drams, and was foot-operated to allow both hands free. You might not believe this, but it was "made black japanned finish." That was referring to a very hard varnish or lacquer made by the Japanese — the reloader was American made. This tool weighed 15 pounds and carried a stiff price tag of $11.20, without shipping charges. However, a 50 percent discount was offered to authorized dealers.

Reloading tools, like rifle scopes, are not modern inventions; both have been around for over 100 years. The old Rummel catalog also shows the shotshell Ideal Pocket Loading Set, to be used in the field. I could go on with other illustrations, but it's easy to see there was no shortage of reloading equipment. However, with factory smokeless powder shotshells selling for about 1½ cents each and centerfire rifle cartridges at about 3 cents, there was no pressing need to reload. I was surprised to find that reloading components were not exactly dirt cheap. Rifle and shotgun powders ran about $1.00 per pound. Primers, wads, bullets and shot were not expensive. The 30-30 Winchester bullet cost $6 per thousand, and some other 30-caliber bullets ran 1½ cents each. Reloading probably didn't appeal to a lot of hunters and, as there was no significant financial saving, they thought it wiser to stick with factory ammo. This same philosophy keeps a lot of today's hunters out of the reloading ranks.

When the handloading mania started to sweep the nation in the late 1940s, the hottest selling point, made by every dealer, was "reload to save money." Don't think that inducement didn't register heavily with returning military veterans who were struggling to find jobs and housing. I know what I went through, working for a label-making factory in Bradford. A dollar was a dollar. In 1949, I was using a Model 43 Winchester 22 Hornet. Factory shells cost 10 cents each and I averaged more than two boxes a month in my quest for woodchucks and crows. The list price on an Ideal Tru-Line Junior reloading press was $22 complete with a set of dies, and even after adding a scale and powder measure the total cost was still well under $50. I was burning at least that much in factory ammo every summer. When the sports

store owner I mentioned earlier offered me a new Tru-Line press, Ideal No. 55 powder measure, Pacific scale, plus four sets of Tru-Line dies for less than $50, I was in the reloading business.

By the time a friend and I got everything set up, I had latched onto an almost new Model 722 Remington 222, topped with an 8x Unertl varmint scope. The new 222 factory fodder was then selling for 14 cents a shell, and that cut pretty deeply into my discretionary funds. Buying in bulk quantities, primers were 50 cents per 100, 4895 ex-military powder was 90 cents a pound, and .224 bullets were 2 cents apiece. I am not going to break this down to the exact fraction each component cost per shell, but a 222 handloaded round cost me less than 4 cents. In other words, I could shoot 4 reloads for the price of one factory round. I had plenty of cases because several chuck hunters who had no interest in handloading gave me their empty 222s. I was sitting on top of the world.

It wasn't long after a handloader set up shop until he realized that reloading was no way to save money. My friend Ken Mollohan, who does some cast bullet writing, claims the money savings pitch is the biggest hoax ever perpetrated on the shooting public. He says he has spent thousands of dollars on equipment, gadgetry and components during the last 30 years. Then, with a wide smile, he also admits he has done ten times as much shooting with reloads as he could have afforded with factory fodder.

Even if the cost factor is the only consideration, reloading still makes sense. The price of components has risen dramatically since the early '50s, but so has the price of factory ammunition. The 222 factory round I paid 14 cents for now costs about 50 cents. In the old days I reloaded a 222 Remington for 4 cents; today, it costs in the neighborhood of 12. Proportionately, the costs are about the same; three or four reloads for the price of one factory round.

The financial aspects of home reloading put hundreds of thousands of hunters and shooters into the reloading game, and more, myself inlcuded, into the reloading business. Around 1961, I was operating over 50 sets of reloading dies. By mid 1960, my scope mounting/sight in shop and writing schedule kept me away from the reloading bench, but in 1968 our oldest son Darrel, who was then a senior in high school, cranked out over 5000 rounds before the big game season — and we were trying to go out of the reloading business.

Handloading doesn't now have the mystique it did in the post-World War II days. Back then there was a feeling of awe about the assembly of the reloaded round. Some gunwriters and many home reloaders took advantage of this. They made handloading sound as if it required superhuman ability. I

well remember one handloader who warned me to "stay clear" of reloading. He implied it was an activity that only a chosen few could understand. A reloading buddy of this so-called expert kept nodding his head during the lecture on the hazards of putting a primer, powder and bullet into a brass case. This took place about 1947, and it temporarily snuffed out my dreams of becoming a handloader. While later watching a demonstration in a sports store, I came to my senses and realized I had been misled by a handloader who was trying to protect his reloading business. I didn't buy reloading equipment that day or even that month, but I knew the goal was within my capabilities. It would just be a matter of time, and it was probably that single decision that eventually put me into gun writing.

Up till now, I may have oversimplified handloading. Perhaps I have made it sound as if it is a routine matter to replace the expended components in a metallic case or shotshell hull. Mechanically that's true. In its basic sense, reloading any empty case is simply the act of replacing the components in the proper order. But when there are literally thousands of load combinations to choose from, many of which could be dangerous, it's easily seen that reloading is a complex subject.

Reloading on the home level is not overly dangerous so long as proper precautions are taken. It would be pure folly on my part to say that primers and powders do not represent a form of danger. They can be detonated or ignited. Common sense tells us that care and caution must be used when handling any form of explosive. It isn't wise to place either primers or gun powder near an electrical receptacle. Plugging in a worn extension cord, for instance, can send sparks flying in all directions and could ignite any nearby powder. Smoking is taboo when reloading for the same reason. These are only two of many precautions that should be taken when handling primers and powders. I'll touch more on this later.

The objective of the handloader is to produce a quality round. During the various reloading operations, a handloader must be repetitious, doing the same thing with every round. There is almost no room for error; ideally, each reloaded round should be exactly like the one that preceded it. But that's where the hitch comes in, and that's what I want to discuss throughout the remainder of this chapter.

One of the most confusing aspects of handloading to the beginner is the type of equipment needed. Paging through a catalog or studying the reloading displays in sports shops mostly add to the confusion. There's so much equipment that it's next to impossible to figure out what is and what isn't needed to set up a reloading bench. Well, the bench is a good place to start.

Like many other shooters, my friend Bill Maxeiner has been loading his own ammo in a corner of his basement for years. It doesn't take a lot of space or a lot of equipment to do a good job.

Over the years, and four reloading shops, I have built a number of reloading benches. My very first one, which I still use, is a check-counter bench from a burned out supermarket. I got two of them for $5 each. When I installed the first one, it was too low for my style of reloading. The bench was 30 inches high, which a friend said was just right for reloading while sitting, but I soon discovered I was a standee rather than a sitter. So I placed the bench on a 2 x 8-inch frame, and it now has seen constant service for over 30 years, although it has gone through a half-dozen or more modifications.

There are really no set guidelines for building a reloading bench. Usually the first prerequisite is fitting it into whatever space is available. I prefer to stand when I reload, so most of my benches for rifle and handgun tools are 36 to 38 inches high. For some reason, I prefer shotshell presses on lower benches. Bench width is about two feet. Length depends entirely on how much space is available, or how much equipment will be on the bench. I have sometimes gone to extremes, putting so much equipment on a bench there was no room to work.

Before I converted a small room in my present shop into a darkroom, I had a bullet swaging bench on one side of it and a reloading bench on the other. The reloading bench ran the full eight-foot length of the room, and had four rifle presses on it. Across from it was a super strong six-foot swaging bench, braced with angle iron and metal posts. It held a casting furnace, bullet lubicator, bullet dropping box, and two jacketed bullet swaging presses. The remaining two-foot space was used to hold a MEC 600 hydraulic shotshell reloading press. The hydraulic pedal on the MEC was easier to operate from the sitting position, so that bench was only 30 inches

high. A foot above each bench was a shelf to hold scales, powder measures, moulds, dies and other paraphernalia. The casting furnace had a hood and exhaust fan. It was the most impressive display of reloading/casting/swaging equipment I ever assembled. It looked like a miniature reloading/casting factory.

That's what it looked like, but that's what it wasn't. In my haste to assemble as much equipment as possible into as little space as possible, I completely forgot about working room. The MEC was the only piece of equipment that could be operated without bumping into a press handle or catching a sleeve on a protruding die stem. Helen took a few photos for posterity, and I moved my darkroom into the infamous reloading/casting/swaging room. Live and learn.

I like a strong reloading bench built out of 2x8 planks. I cover the top with a solid sheet of half-inch plywood, and paint it white. It's easy to keep clean and has a nice appearance. Even though 2 x 8s are strong, I still put a 2 x 4 post directly under the rifle press. Full length resizing exerts a lot of pressure on the bench top, and the post prevents it from bending or buckling. I go a step further by bolting a foot-square 3/8-inch steel plate on the table top. I set the press on the plate and bolt through it and the bench top. Underneath, I use very large washers under the bolt nuts. In some cases, I install a quarter-inch steel plate on the underside of the bench top. The washers or plate allow the bolts to be drawn down with tremendous pressure, and there's no possible way for the bench top to buckle or give.

My RCBS Big Max swaging press is bolted through a 3/8-inch 18 x 18-inch steel plate. The 4 x 4-inch post under the press prevents the use of a second steel plate, so large heavy washers are used instead. This is a very strong setup, as it should be for a swaging press, and there is no discernible give or spring when swaging or full length resizing.

I think the ideal size for a reloading bench is 5 feet long and 2 feet wide. Height is optional, but 36 to 38 inches should be about right for rifle presses. As it's difficult to operate a powder scale or measure much below eye level, I install a 2 x 10-inch shelf roughly 14 inches above the entire length of the bench. That puts the shelf about 52 inches above the floor and slightly below the direct line of vision. Don't make the shelf too high or you will have to reach up to the powder measure or scales, and that is awkward.

These measurement are only suggestions. They should depend upon the user's comfort. The reloading bench is a personal piece of equipment. It can be a massive design of iron and oak in a garage or basement, or it can be a portable affair kept in a space closet. A friend has a 3/4-inch thick steel table welded to a 4-inch pipe support post in his basement. The most ingenious

design I encountered was a mahogany cabinet at the end of a hallway. The cabint's door dropped down and was supported by a set of telescoping legs that snapped-locked into place. The reloading press was bolted to the door permanently on a hinged setup, and the scales and powder measure fitted into slotted brackets on a sliding shelf which pulled out of the cabinet above the reloading press. It took less than a minute to drop the door, snap the legs into place, unhinge the press and lock it with a large wingnut, pull out the shelf, retrieve the scales and powder measure out of drawers and shove them into the slotted brackets. Powders, primers and bullets were locked in the bottom part of the cabinet. This fellow's entire reloading room was compressed into a cabinet 4½ feet high, 2½ feet wide and 2 feet deep. There's not a lot of extra space in a five room apartment on the fifth floor of a city apartment building, but he overcame the problem nicely.

It's obvious that the reloading bench should be designed according to the space available. However, it should also fit the person who will use it. Choose the measurements you are comfortable with but, take it from the voice of experience, don't bolt or spike anything solid until you are certain the measurements are what you want.

Over the years I have examined a fair number of reloading benches. Some were works of art, others were nightmares in disguise. The basic requirement of a reloading bench, especially one used for swaging and full length resizing, is enough strength and solidity to fully resist bending during the various operations. It also should have enough top space to hold all the necessary equipment with working room to spare. That's it. You can use rough lumber, finished boards, cabinet type boards or whatever. No matter what it's called, the reloading bench is just a strong rectangular table. Its looks are not as important as its strength. That's a point to remember.

The last piece of advice on the reloading bench is to build shelves or cupboards under it. No other place in a shop can gather as much junk as the space under the reloading bench. Use this space to install locked cabinets for powders, primers and bullets. That's about it. The measurements and ideas given here are just one man's suggestions. The bench you build should reflect your ingenuity in satisfying your needs.

In earlier years, choosing the right reloading equipment was a matter of grave concern. Most new converts knew little about the subject, so they were at the mercy of the hucksters. A variety of catalogs, brochures and flyers filled the mailboxes during the 1950s. Each manufacturer proclaimed his press to be stronger and more efficient than any other on the market. I know all about that situation; I swallowed a good bit of their strong medicine, and so did a lot of my reloading friends.

My Tru-Line Junior outfit cranked out a lot of ammo, but the need for a full length resizing outfit forced me to look for another press. The Potter Combination Duplex press was the ultimate in the early '50s. I read about it, discussed it with other handloaders, and dreamed about owning one. Since it carried a list price of close to $100, it was far beyond my financial means. But Herter's, Inc., in Waseca, Minnesota, had an array of full length resizing presses I could afford, and I settled for a turret model that held six dies. The Herter's press turned out many thousands of rounds for me; but I never forgot the Potter outfit. Yet, close to forty years and a good many presses later, I have never used or even seen the press of my dreams.

Back then, a reloading bench was equipped mostly by the piecemeal method. In other words, no two pieces of equipment on the bench were made by the same company. So many conflicting claims were made that countless new handloaders ran the gamut of manufacturers in a futile attempt to have the best of each piece of reloading equipment. For instance, I used an assortment of Herter's, Echo, C&H and RCBS dies. It was similar to keeping up with the Joneses. One friend claimed there was nothing better than Herter's powder measure, but another one offered to bet $5 his Redding was more accurate. So it went. Confusion was everywhere, but by the late 1950s, a reloading kit hit the market. I remember a friend getting a Lyman "Quick Load" package that included a Tru-Line Junior press and a Lyman No. 55 powder measure, a set of dies and a reloading manual.

By 1960, a calm settled over the reloading community, and some semblance of order was initiated. A new approach to handloading emerged as more data became available. Bullet and powder manufacturers offered informative easy-to-understand manuals that laid to rest much of the fear and mystery that had clouded the reloading scene for years. Instead of preaching the money-saving aspect of reloading, accuracy from uniform reloading procedures became the new quest of the home reloader.

Handloading changed the shooting habits of Americans. Hunters who had seldom fired their big game rifles between seasons were building benchrests to test their homespun ammo. Sportsmen's clubs built rifle ranges or added more benchrests to existing ranges. Handloading made thousands of American shooters competitors with themselves. In truth, that's what handloading does.

When I built my first crude benchrest, it was strictly for sighting in my woodchuck rifles, or so I thought. I knew I would test some reloads from the 100-yard bench, but didn't figure at the time that Helen and I would soon be burning 50 rounds or more an evening shooting groups, and that we would do this two or three evenings a week. We quickly developed smooth routine

We ate supper, shot groups, and while she washed the dishes, I reloaded another batch of ammo. If time was available, we would then head for several nearby pasture fields and hunt chucks. With reloaded ammo constantly available, we kept the barrels on a 220 Swift and a Remington 222 warm, and that might be an understatement.

We not only competed against one another, we also competed with ourselves. If I hadn't been a handloader, we couldn't have shot nearly so much. I couldn't have bought that much factory ammunition. I used most of the profits from my reloading shot to keep us in components. But it was well worth the cost. We enjoyed ourselves and both of us became better field shots.

Before I discuss various types of reloading equipment, I want to make it very clear that quality ammunition has little to do with the amount of money spent on equipment. Quality reloads come from quality handloaders, and you can write that in stone. If I had thousands of dollars worth of wood working equipment, I could not build a chest of draws or a roll-top desk. Yet a late friend, using only a minimum number of hand tools, could build elaborate desks and cabinets of all descriptions. You see, he was a cabinetmaker, and I am not.

Still, a lot of handloaders want the finest in equipment. That's not necessarily bad, but it isn't a guarantee that their reloads will be any better. Let's step back to 1948 when Marcy Prescott won the Donaldson Trophy at the Johnstown, New York, benchrest tournament. Marcy, working with a single cartridge case, used a simple Ideal Model 310 nutcracker tool to load each round at the firing line. The label "nutcracker" pretty much describes that Ideal tool. It resembles a nut cracking tool or an oversized pair of pliers. Back in those days, the price tag for the hand-operated Ideal 310 was well under $15. I might mention that Marcy's winning 10-shot group at 200 yards was under 1½ inches. Not impressive by today's benchrest standards, but very creditable in 1948.

I am a relatively new convert to the computer and printer, which writers refer to as a word processor. Most of my typing experience has been with a typewriter. I do not understand all the jargon so freely used in word processor manuals, and I am not certain what all the equipment and various programs do. It's frustrating, and I'm sure the beginning handloader has the same doubts and apprehensions when leafing through a catalog of reloading equipment. Which type of press is best? Can a press that costs $90 be as good as one that costs $190? Similar questions arise in regard to scales, powder measures, die sets, etc. It is confusing.

Let's take a more logical view. A rifle press should offer the following

features: be strong enough and have sufficient leverage to easily full length resize a case and have a priming arm for seating primers. Those are the two basic requirements. With this type of press, and the proper dies and shellholders, you can reload for a lifetime.

The old nutcracker-type tools did not have the strength or mechanical advantage to full length size cases. That required a bench-mounted tool, and the earliest one I remember that attained any popularity was the Pacific. This was a C-type tool; that is, viewed in profile it was shaped like a capital C. The top was drilled and threaded for a 7/8-14 die. These came in sets of two, normally, one for resizing and decapping the fired case, the other for seating bullets. The bottom of the C had a flattened area which bolted to the bench and an extended section with a near-vertical cylindrical hole through which a shellholder-topped ram could be raised and lowered by means of a steel handle. On the downstroke, a new primer could be inserted by means of a swinging arm.

Later, H-shaped tools came along, the dies being screwed into the crossbar, and O tools, which closed in the open front of the C design, eliminating the springing which sometimes occurred when C's were used for bullet swaging. These early tools worked on the upstroke; that is, the handle was raised to do the heavy work of case sizing, etc. Later, Fred Huntington developed the compound leverage tool, which greatly increased their mechanical advantage and thus made sizing and swaging easier. All of these that I can think of — and I believe all modern tools function this way — work on the downstroke.

Currently, RCBS's Reloader Special-3 is one of a number of single-stage tools that are ideal for the new reloading buff. The press has an O-frame for additional strength for resizing and case reforming, it incorporates a positive ram priming

Bob Bell still does much of his metallic reloading on an old Super Pacific. He started with a Standard Pacific — the original C-type tool — in 1946, and still likes a tool that works on the upstroke.

system, and has a counter-balanced handle that stays upright when not in use. All standard 7/8x14 dies can be used in the Reloader Special-3. As an added feature, 12-gauge shotshells can be loaded with the RCBS shotshell die set. The sizing die full length resizes the case (neck sizing dies are also available) and punches out the old primer. When all cases are sized and primed, the resizing die is replaced with the bullet seating die. A single stage press is the best bet for the beginner and will handle most reloaders' needs.

On my old Herter's turret press, I could move to the next die by turning the turret. I appreciated the time-saving factor more with three-die handgun sets than with two-die rifle sets. When I purchased the Herter's press, I was convinced that speed was a major factor in reloading. The turret press eliminated constant die changing. I recall often having three sets of dies in the turret. All I had to do was reset the powder measure, and that was speed loading in that era.

Let me stress that speed should never be the main factor in reloading ammo. Herter's was not the only company to emphasize speed in those days. Lyman had a fine turret press, and Herter's also offered a two-ram press and seating dies. Such presses were the progressive tools of that time period.

The picture has changed today. A number of excellent progressive tools are now available, for both rifle and handgun cartridges and shotshells. These differ from single-stage tools in that they are more or less automatic. That is, once various supply systems are loaded with components and things are on stream, every pull of the operating handle produces a loaded round. There's no point in trying to describe the operations fully. It's enough to say that they automatically perform all the steps of a single-stage tool — resizing, repriming, dropping powder, and bullet (or shot) seating. The operator, in addition to functioning the handle, must make certain that the supply of components is not interrupted. If it is — if a powder hopper goes dry and he doesn't notice it, for instance — there are problems.

I'll probably fail to mention some excellent tools, but at this time, available progressive presses for handgun cartridges include the C-H Mark V Auto Champion, the semi-progressive C-H 444-X Pistol Champ (this one requires three strokes of the handle to produce one round), the Dillon Square Deal, the RCBS Green Machine, R.D.P. "The Tool," and of course the STAR Universal. For rifle cartridges, there's the Dillon RL-550, Hornady Pro-Jector, Lee Progressive 1000, and RCBS 4x4. Some of those best known as progressive handgun tools also load rifle ammo, and some tools, such as the Camdex, are essentially small factories, intended to be commercial setups or perhaps for large gun clubs. Progressive shotshell loaders include the Bear Honey Bear, Hornady 366, MEC 650 and Grabber, and Ponsness-Warren

Size-O-Matic 800. All of these turn out a lot of shells very quickly.

Before setting up or attempting to operate any reloading press, and especially a progressive type, the instructions should be thoroughly digested. Another bit of advice I might offer is to load single rounds until you understand each operation. At first, do not try to run all stations at once. Start with a single round and take it through all the operations. I may do this a half-dozen times with a new tool until I'm certain I have the operation figured out.

I am not trying to throw cold water on any handloader's dreams of owning a progressive press. I just want to add a note of caution. First, most gunwriters and experienced handloaders agree that progressive-type presses are not the best for beginners. This is not a reflection on anyone's intelligence; it stems from a genuine concern over their limited experience. I'm prone to agree. I believe it's best for a novice handloader to start with a simple setup. The basics should be learned first.

Start with simple equipment and learn every step by doing it. For instance, a beginner should learn to check every resized case for possible neck splits or signs of case separation. Cases should be checked for length and trimmed if too long. Primer pockets should be cleaned and flash hole diameters gauged. All this should be done regardless of the type of reloading press being used, but it's especially important for the beginner. How else will the fundamentals be learned? Today's powder measures are accurate, but in the beginning the handloader should weigh each charge. Doing these things establishes a certain degree of consistency and makes the handloader more observant and careful.

This doesn't mean I'm against the progressive rifle or shotshell press. Far from it. When I was trapshooting regularly, I would often load 150 rounds in thirty minutes on a Ponsness/Warren 800B Size-O-Matic, without any fuss or bother. The same is true when a few thousand 223 rounds are needed for a prairie dog hunt. That's where the Hornady Pro-Jector shines. No, sir, I am not opposed to progressive presses in either shotgun or rifle/pistol combinations, but I am concerned that starting with a sophisticated metallic press might prevent the new operator from absorbing the basics essential to good handloading.

Progressive reloading presses are a good bit like cruise control on an automobile. While cruise control takes a lot of the work out of driving, it has built-in hazards. On long stretches of open highway it can lull the driver into a semi-detached state. His subconscious mind is driving. The car will move at the same rate of speed uphill and down through curves or small villages, if not controlled. With all its benefits, the driver must always be in charge. The

same rules apply to the operator of a progressive reloading press. It demands the full attention of the operator. On a large run, it all gets so routine it's easy to miss seeing that the powder measure or priming tube is empty. It's a real shocker to discover one of these mistakes. There's no alternative but to stop and find the defective rounds. I try to prevent this by stopping frequently to refill the primer tube and powder measure. At the same time, I check the primer and bullet seating depths of a half-dozen loaded rounds. Some progressive press owners claim that taking the time to do such things defeats the purpose of a progressive, but I have always believed that an ounce of prevention is worth a pound of cure.

There's nothing more annoying and time consuming than weighing a hundred reloaded rounds to see which ones don't have powder. To get some firsthand evidence for this problem, I weighed a dozen 223 Remington rounds loaded with Remington 7½ primers, 21 grains of Reloder 7 and 50-grain Speer bullets. The average was 171 grains. That means a cartridge without powder would weigh 150 grains. That sounds simple enough, and checking it shouldn't cause much of a problem. Try it. It's no picnic with even a single box of ammo. Checking a large batch is a real pain. Sometimes it's possible to shake a cartridge slightly to hear or feel the powder. But when the case is nearly full, it's either weigh them all or pull the bullets. I always do the latter. Seeing is believing, and I want to look directly into each case. It takes more time, but it make me feel better.

As mentioned, reloading kits were not available when I started to reload. The press was usually one brand, the scale another, and a powder measure could be anything from the Ideal No. 55 to a homemade dipper. That has all changed for the better. A new loader can purchase a kit such as the Hornady package which includes an 00-7 single stage press, a set of reloading dies (buyer selects caliber), a powder scale, powder measure, case lube, primer turning plate, reloading block, and two static resistant funnels. The package also includes a chamfering and deburring tool, large and small primer pocket cleaners, three neck cleaning brushes with an accessory handle, and a copy of the *Hornady Handbook of Cartridge Reloading*.

Eventually, other equipment such as a case trimming tool, case cleaning tumbler, automatic priming tool and bullet pullers might be added, but the starting kits have all the equipment needed to set up a bench for reloading metallic cartridges.

The more you handload, the more equipment you'll buy. At least, that's the way I see it. The Herter's turret press I mentioned is still in sound operating condition after thirty years of use. Yet, I have gone on to such tools as the Bonanza Co-Ax, the RCBS Rockchucker, Hornady 00-7, C-H Model

"H," and the Lyman T-Mag turret press. The Bonanza is not a swaging-type press as the others are, but it's capable of full length resizing. With its automatic universal shellholder, top priming device and the snap-in die change feature, it's unbeatable for fast setups and quick die changing. It's a high quality reloading press of unusual design and good workmanship.

When an acquaintance decided to go into the reloading game, he ignored my start-simple advice and purchased an expensive press and all necessary gear plus a lot of gadgetry. Money was no problem; he wanted the best of everything. You know the answer. He was out of reloading almost as quickly as he had gotten into it; he had thought equipment was the key. It isn't. Handloading is in the person working the press handle. It's as simple as that.

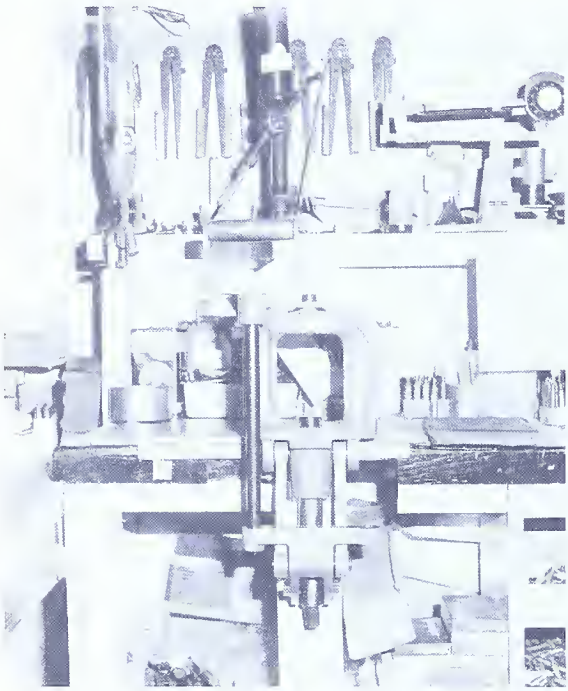
Some good points to remember are: Start with simple, easy-to-use equipment. Buy only the basics at first. Reloading manuals from the early days are oudated, so buy and study several current ones. Cross check them and refer to them often when loading. Keep all reference material up to date. Keep good records of your own load results. Avoid maximum loads until you have enough experience to recognize danger signs as you work up to them. Finally, give yourself time to learn. Work alone, and stop if any problem comes up that you don't understand. Seek advice and help from more experienced handloaders, and stick tenaciously with the "Three Cs" formula.

How To Reload

Handloading is not beyond the capability of anyone who uses common sense. I have stressed for years the importance of the Three Cs — Care, Caution and Concern. This formula might sound a little dramatic, but it contains the necessary ingredients needed to be a quality handloader. If these three Cs aren't an integral part of a handloader's philosophy, reloading can be a risky pastime.

I don't have to explain the formula; it speaks for itself. In reality, it is nothing more than using good judgement, being aware of the built-in problems when handling powders and primers, and having a genuine concern for the quality of loads being produced. Anyone operating a radial saw or a power lawn mower should also face up to the Three Cs. That's true to some degree in all aspects of life.

One of the reasons I got into the gunwriting game was to encourage hunters and shooters to become involved in handloading. Thirty years ago I tried to point out the simplicity of reloading, along with the possible hazards. Today, I'm writing basically the same material. Handloading is undoubtedly the most profitable and one of the most entertaining aspects of shooting. It's



Sometimes I use this big RCBS tool for bullet making as well as full length sizing, which puts a lot of strain on the bench. So to keep it from buckling, I installed a half-inch steel plate between the tool and the bench.

as much a teacher as a money saver. Any way you look at reloading, it's beneficial.

Despite all the manuals and articles on handloading available today, many potential reloaders still aren't sure how it's done. There's no better time than now to learn.

It all starts with an empty rifle or handgun case or shotgun hull. As most new reloaders start with the rifle, I will follow the same pattern.

It would be impossible to reload if the handloader didn't have an empty cartridge case. That's one ingredient almost no handloader can make. The case also happens to be the most expensive component in reloading, so handloaders are indebted to the ammunition makers. How else would they get the empty?

When a cartridge is fired in a rifle chamber, the powder in the case burns rapidly, generating a high volume of hot gas which, in turn, generates a lot of pressure. The case head moves back against the bolt face, and the case walls and neck expand to the limits of the chamber. The bolt and the chamber walls contain the outward pressure of the case, so the gas takes the course of least resistance and pushes the bullet through the bore.

Immediately after the bullet leaves the muzzle, any remaining gas pressure in the bore is dissipated through the muzzle, and back in the chamber the natural elasticity of the brass case causes it to retract from the chamber walls;

without this physical property, the case could not be extracted. However, the case does not perfectly resume its original dimensions. At this point, the case body and neck are slightly larger than their original dimensions. Before the case can be reloaded, it must be at least partly resized and decapped. To get the case body and neck back to original size, or close to that, the case must be full length resized. This is accomplished by running the empty case into a precisely machined and hardened die. As the case approaches the full depth of the die, a decapping pin on the end of a rod which enters the neck of the case pushes out the spent primer. When the resized case is being pulled out of the die, a tapered plug on the decapping rod expands the neck so its internal diameter is slightly smaller than the caliber of the bullet. The neck must be smaller than the bullet to hold it tight; otherwise the bullet would fall out or slide back into the case.

Resizing can be done by three methods: full length resizing, neck sizing, or partial sizing. As just explained, full length resizing essentially squeezes the entire case back to factory specifications. Neck sizing does only what it says: it sizes the neck only. The body portion of the die is oversize so it does not contact the case. The main body of the case remains the size of the chamber it was fired in. The decapping procedure is the same as in the full length resizing die. Neck sizing is supposed to improve accuracy because such a reloaded case is more snug in the chamber before firing, thus presents and keeps the bullet in better alignment with the bore than a case which doesn't fit the chamber quite as well.

Partial sizing occurs when a full length die is backed off a couple of turns. This prevents full contact between the case and the die. Usually, about half the length of the neck is sized, plus some of the case body toward the head. This reduces work hardening of the brass, giving longer case life, and at the same time often makes easier chambering than with neck-sized cases. Like neck sized brass, partly sized cases will not always chamber in rifles other than the one in which originally fired, as full length sized cases are supposed to do (but sometimes do not).

Case sizing is one of the most controversial points in reloading. To full length resize or to neck size only is the usual question. Every handloader has strong opinions on this touchy subject. Often times, partial sizing serves as a compromise. I am not going to try to change anyone's opinion. I long ago learned that will never happen. A true neck-sizing buff will always believe full length resizing is a case destroyer. I've been deep in the hassle and have heard all the arguments many times, but still hold to the idea that, for all around hunting ammo, cases should be full length resized every time they are reloaded.

I base this conviction on more than ten years of custom reloading for all the common calibers, from being a handloader for almost forty years, and also on evidence gathered from having a gun repair shop. On the evening of the first day of buck season, it was not unusual to remove two to five stuck handloaded cartridges or cases from rifle chambers. Any type of action could be involved, but most were pumps. During the entire season, the total could reach a dozen. In almost every instance, the hung-up case or cartridge prevented the hunter from getting another shot. Most of these loaded rounds failed to completely enter the chamber but wedged so tightly the extractor was unable to pull them out.

I can't say all those problems came from cases being necksized only. That would certainly lend credence to my belief, but it wasn't the only reason. For now, let's look at one of the main reason many handloaders neck size only.

The complaint that full length resizing weakens the case at the web (where the case cavity ends and the sold case head begins) can not be contested. It does weaken the case at that point. As the case is forced into a full length resizing die, I believe the brass literally flows back toward the case head. When it reaches the solid head, it humps or forms a ridge ring around the case, since there is no place for the brass to go. This ridge is flattened inward when the case is shoved completely into the die, flexing the brass at the web. Each reloading weakens it a bit more. Sooner or later, it will rupture at this point.

Unfortunately, there is no way of predicting when a case is going to crack or rupture. I have run tests of this, but there is no way that case life can be accurately predetermined. For instance, in one test I fired a 220 Swift — a case which some handloaders claim is noted for rupturing — twenty times. Each time I reloaded the case, I pushed it into the resizing die twice to iron out the ridge ring. In essence with each resizing I was working the brass twice at its weakest point. Yet after all this shooting and sizing, the case did not rupture or show signs of excessive stress. I've often wondered if that case was the exception instead of the rule. Here's a rebuttal-type incident.

Long ago my brother-in-law C. J. Clawson mounted a scope on a splinter-new Model 70 Winchester 220 Swift. He gave me the honor of sighting it in with new factory ammo. Through the scope I saw the first shot strike close to the bullseye, but I knew something was wrong because smoke was spiraling out of the action. The case had separated just ahead of the web. In fact, the head came off the case just as it came out of the chamber.

We were alarmed but could find nothing wrong with the chamber. The case didn't show any scrape marks or an indent where a piece of foreign material might have been against it. Before firing again, I chambered and

closed the bolt several times on a cartridge and then inspected it carefully. Everything appeared to be in order, yet the next shot burned a small hole through the case just ahead of the web. Using a flashlight and dental mirror, we thoroughly examined the chamber. The burn through had taken place less than a half-inch deep in the chamber, so we could insert the tip of the little finger inside to feel for a flaw. There was neither an inclusion or extrusion; the chamber was mirror smooth. It was a mystery.

We firmly attached the rifle to a tire for the third shot, and fired it by a long clothesline which allowed us get behind a building. There was no sign of stress. Two more shots from the tire convinced us there was nothing wrong with the rifle; it had to be with the ammo. C. J. switched to another box of the same brand of ammo, and we had no further problems. In fact, he shot that Swift for years without another case problem.

I realize that was a remote incident. During the decades that I fired numerous Swifts, I had an occasional rupture or split neck, but I felt both normally came from using old brass rather than from full length resizing.

Another thing that makes me wary of neck sizing for hunting loads is the variation in chamber dimensions. I have never made sulfur casts of the chambers to see how much variation exists in, say, five 30-06s of the same make, but I do know for a fact that all chambers are not perfectly round. Sometimes one of the cutting edges on a reamer is not as sharp as the others to begin with, or is not sharpened as well when touched up, and this causes a slight wobble which results in an out of round chamber. In such a situation, full length resized reloads will probably chamber easier than neck sized ones.

Maybe I should explain that a chamber isn't cut with just one reamer. First, a barrel is usually drilled out with a conventional drill bit to remove as much metal as possible. Next, a roughing reamer is used to cut the chamber close to the desired dimensions. The final step is to bring the chamber to exact dimensions with a finishing reamer. Sometimes this reamer has an extension that also cuts the throat; other times this is done separately. I have made this sound relatively simple, but is isn't. Chambering requires precise work to close tolerances. Cleanliness is mandatory as both reamers have pilots on the throat end that fit precisely into the bore to keep the reamers properly aligned. After the final reaming is finished and the chamber is checked with Go and No Go gauges (the chamber is reamed to a depth that accepts the Go gauge but will not accept the No Go gauge), the chamber is polished. Chambering definitely is not a job for the inexperienced. The difference in length between a Go and a No Go gauge is only a few thousandths of an inch.

When a chamber is not perfectly round, the extracted case will not be

round. Expanding high pressure gases push the case walls to the exact contour of the chamber walls. If an out-of-round case is neck sized only, it will be hard to chamber. Many competitive shooters neck size only, but there's no question about the concentricity of the chambers they are using.

With the ready availability of all kinds of cases today, getting the last possible load out of a case is a shortsighted view. At one time, I tended to use cases until they started to go to pieces. That led to some scary moments during the course of shooting more than 6000 rifles. Twice during the years, case ruptures caused near disastrous accidents. One incident involving a pump rifle blew the detachable magazine out of the receiver and froze the action as if it had been welded. The second split a bolt action rifle stock, blew out the floorplate, and partly opened the bolt. Admittedly, these two episodes were the result of improper reloading, but they are perfect examples of what can happen when a case ruptures, releasing thousands of pounds of pressure into the action. No matter how strong the action or how exact the headspacing is, the case must not be allowed to rupture. That's rule number one. I figure beating the odds twice is enough for me; I don't want to push my luck further. Consequently, I don't reload cases more than four times, and I discard old cases or any that show signs of weakness or stress.

With this testimony, I would appear to be a strong proponent for neck sizing. I admitted that full length resizing weakens the case at the web, so it would seem natural that I wouldn't want to shoot a weak overworked case. That's a good argument, and I won't contest it. However, experience has proved to me that fresh brass is not likely to succumb to failure from only a few resizings. Allow me to point out that I scrutinize every case before and after every resizing. If there is the slightest stress mark, I toss it in the junk box. If you ever experience a full scale case rupture, and I hope you won't, you'll understand my cautious approach.

I'm not trying to instill fear. But I am advocating the examination of cases after neck or full length resizing, and that you immediately discard any that have split necks or appear to be stretched or weak in the web area. Each time a case is fired, it stretches somewhat, and the weakest point is where the cavity meets the solid head. Normally, a bright ring forms around the case at the web. It will usually be more apparent in high than moderate velocity cartridges. I keep a sharp eye on the ring. If it's really bright, I discard that case pronto.

There is no absolute method for predetermining the life of a case. Common sense is the best approach. Varmint hunters who do a lot of shooting should keep close track on how many times a batch of brass has been fired. When Helen and I were group shooting constantly, I marked on

the box the number of times the cases had been reloaded. That was more than thirty years ago, so I can't remember now at what point I discarded the brass, but I know I reloaded each case as many times as possible back then, which still scares me when I think of how foolish that was.

Possibly the strongest argument for neck sizing is accuracy. It is claimed if the case fits the chamber to the nth degree, accuracy will be enhanced because the case will do less expanding and stretching. Well, if you recall, I mentioned that many competitive shooters neck size only, but I also pointed out that the competitive rifle's chamber is reamed to exact tolerances. Also, competitive shooters seldom, if ever, fire top pressure loads. We can't compare competitive reloading with big game rifle reloading. Then there's the fact that competitive shooters as a class are excellent shots, and know how to get the best from their reloads and rifles. The average handloader doesn't have their experience.

I full length resize as a precautionary measure. I want to be sure the shell will easily enter the chamber. Hence, I double resize each case. I've been told this practice quickly ruins good brass but, when I'm on a deer stand, I want to know every cartridge will go in and out of the chamber easily, and that's why I have always cautioned big game hunters to be careful when using ammunition that has been reloaded by a friend or someone selling ammo.

A few seasons ago Milt Anderson and I were packing my four-wheel-drive for a buck hunt in McKean County. I knew Milt used a Model 700 Remington chambered for the 6mm cartridge. As I was going over my check list, I mentioned shells to Milt, and that I had a full box of 100-grain 6mm Remington loads. He said he didn't need them as he had two fresh boxes of reloads. I asked if he had run them through the chamber, and he replied in the negative. When he tried them, he discovered not one would chamber easily and several wouldn't chamber at all. Five of the factory rounds were used for a new sight-in, and Milt went out in the morning with 15 factory shells in his pocket.

What had gone wrong? Well, it was definitely a resizing problem. When we returned from the hunt, I pulled the bullets from several of the cartridges that wouldn't chamber and resized the cases. The problem was solved. This is what I mean by being extra careful. Milt had not fired these shells originally, and the problem stemmed from not resizing the full length of the case. Had we not checked them, he would have been out of luck 100 miles from home.

As long as I reload, I intend to full length resize every case to be used for big game hunting. Ammo for my Remington 40 XB-BR 222, I neck size on an old Model 28 Belding & Mull straight line press. Antiquated and slow as it is,

The Bonanza Co-Ax press has a universal shellholder, which is a convenient feature. To the right is a Brown Bair III, now discontinued but a strong outfit for bullet swaging.

it is simplicity at its best, and it still turns out top quality ammunition.

The basic functions of reloading an empty case consist of replacing the primer, powder and bullet. However, other factors are involved. I have often stated that the key to handloading is repetition — doing the exact same steps with the last case as with the first. For top quality reloads, every step must be taken. Empty cases should be sorted by brand names. It isn't wise to mix cases as different makes often vary in capacity. It's really best to start with several boxes of new unprimed cases. The handloader can then keep accurate records on how many times each case has been reloaded.

Most new handloaders don't start that way. Either they have built up a supply of empties, or they get them from friends. Let's take a look at the reloading steps with fired brass.

The first step is to wipe the outside of each case with a soft dry cloth. Then check each case for telltale splits in the neck or signs of stress at the web. At the same time, each case should be checked inside to see if there's anything in it. Carrying empties in a pocket is a good way to get lint or foreign material into the case. When the entire batch is ready to load, the next step is lubricating the inside of the neck and the outside of the case.

When I started, this was a touchy issue. We argued long and loud over the type of lubricant to be used. For years, I was a castor oil fan, but today better lubes such as RCBS Resizing Lubricant and Hornady's One Shot case lube take the oiliness out of case lubricating. I lubricated many thousands of cases with castor oil. I stretched a piece of wool cloth over a 6 x 8-inch pine board,

sprinkled it with castor oil and rolled the oil into the cloth with a round piece of brass. To use, I'd place half a dozen empties on it and roll them back and forth under the palm of my hand. It's important not to get an excessive amount of oil on the shoulder. When the case is forced into the resizing die, excessive oil on the shoulder acts like a hydraulic system and dents the shoulder. Beware of over-lubricating. There should be no visible sign of oil on the case. Only a film is needed.

A friend puts several drops of castor oil on his palms and rub his hands together briskly. He then rolls each case between his palms. He lubricates a box of empties in a matter of seconds.

A tiny bit of lubrication helps the expander plug slide through the neck easier, and prevents neck stretching. I built a machine, which I will describe later, to do a variety of operations including inside neck cleaning and lubrication. There are several ways to lubricate the inside of the neck.

The Bonanza Case Graphiter is a slick method for cleaning and lubricating the inside of neck. It's a small plastic box with three nylon brushes that will accommodate all calibers from 22 to 35. The box holds powdered graphite. A case is pushed down over the correct size brush into the powdered graphite and pulled back over the brush. This cleans and lubricates the inside of the neck.

Another method is to use a lightly lubricated nylon brush or rifle swab, inserted in the chuck of a hand drill. Clamp the drill in a vise, lock it in the running position, and run each case neck over the brush. The spinning brush will not only lubricate but also clean the burned residue out of the neck. I use a similar system, and I lubricate only the neck portion of the case. Don't get oil or grease into the main body of the case. It can contaminate the powder and possibly cause ignition problems.

Before getting into the actual resizing of a case, it's imperative that the resizing die be installed properly in the press. To completely resize a case, it must be inserted as far as it will go into the resizing die. Move the press handle to raise the shell holding ram as far as it will go. I might mention here that the proper shellholder for the case being loaded must be in the ram of the reloading press. Next, screw the full length resizing die down until it firmly touches the shellholder. Lift the press handle slightly and screw the resizing die down approximately 1/8th turn. Keep adjusting the die until the press handle breaks over center when the shellholder is pushed firmly against the bottom of the die. This guarantees the empty case will be inserted its full length into the resizing die. Keep pressure on the bottom of the die while turning the main die lock ring tightly against the top of the press. I normally snug the lock ring tight with channel lock pliers. Tighten the screw in the lock

ring, and the full length resizing die is set for that press and shellholder.

A resizing die also incorportes a threaded decapping rod which has a neck expander on it. The expander plug can be an adjustable ferrule on the rod, or it can be a part of the lock nut that holds the decapping pin. Different die manufacturers use different systems, but they all work.

The decapping rod is adjustable vertically, and is held in place by two nuts on top of the die, the top one serving as a locking nut. Loosen both nuts and screw the rod in or out until about 3/16ths-inch of the decapping pin protrudes from the bottom of the die. Don't screw the decapping rod down too far or it will strike the inside of the case head and bend the rod. The pin should protrude only far enough to knock out the spent primer. Screw the decapping rod nut tight against the top of the die, and then tighten the lock nut against the main nut. Always make certain the decapping rod is locked tightly in position.

Loosen the lock nut on the die itself and screw it up as far as possible. Most lock nuts have an allen head screw or a regular slotted screw for tightening the split lock ring. Also, some dies have solid lock rings that are locked against the die with an allen screw. On this type of die, a small ball of lead is inserted between the allen screw and the threads to act as a buffer. When the allen screw is loosened, it may require a pair of channel lock pliers to break the lead loose and allow the lock ring to turn freely.

The next step is to put a lubricated empty into the shellholder and raise it into the resizing die. Let me insert a word of caution here as this is the very moment when a case is most likely to be stuck in the resizing die. Use extreme care with the first case. Push it into the die slowly. Pressure will build, but if it seems excessive, withdraw the die and check to see if the case is properly lubricated. My standard approach with a new die, or one that hasn't been used for a long time, is to shove the case part way into the die, withdraw it and re-lubricate it. I may repeat this operation three times, but I never shove a hard-running case into a resizing die. Never. The consequences can be severe. For example, the rim can be pulled off the case when trying to remove it from the die. That's a real problem. After the first couple of cases, the die is lubricated, and a case can be resized with one smooth sweep of the press handle.

During the resizing operation, three things happen: the spent primer is pushed out, the main case is brought back to its original dimensions, and the neck is reduced and then expanded in diameter so it will provide sufficient neck tension when a new bullet is seated.

Before installing a new primer, the primer pocket should be examined. Residue will build in the primer pocket and can keep the primer's anvil legs

from seating or resting firmly on the bottom of the primer pocket. If this residue is not removed, it can cause a misfire. The primer's anvil legs must be seated on the bottom of the primer pocket, or the primer will move forward when struck by the firing pin. This cushioning of the firing pin's force can result in a misfire. It's important to clean the primer pocket often. I do it every time I reload a case.

The flash hole does not get the attention it deserves. The flash hole is the channel from the bottom of the primer pocket into the powder chamber of the case. When the primer ignites, a hot flame is squirted through the flash hole to ignite the main powder charge. Perhaps surprisingly, there's more to a flash hole than meets the eye. Its diameter is directly related to how the main powder charge will be ignited. Too large a flash hold can allow more of the flame to contact the powder in the moment of ignition. This can increase pressure.

Flash hole gauges (normally a set of two) aren't in vogue, but I still use them. A flash hole gauge is a small round or octagon piece of metal which has a different diameter pin on each end. One pin is a Go, the other a No Go. For instance, on a 22 Hornet case, the .070 pin, on the small flash hole gauge, should slide through the flash hole, but the .077 gauge should be too large. If the No Go pin enters the flash hole, the hole is oversized and the case should be discarded. The large flash hole gauge is used on all other cases, including magnums. The .080 diameter pin fits, but the .086 pin should not go into the flash hole. Flash hole diameters can vary slightly within minimum/maximum measurements, but I recommend you don't use cases that have oversize holes. I think uniformity in flash hole diameters is important. I use a drill bit that will fit snugly into the largest "normal" flash hole in a batch of cases and drill all the holes to that size. Since pressure might increase somewhat, cut down several grains on the powder charge to start with. Reaming of the flash holes is a one-time operation.

Seating the primer should not be an act of strength. I wasn't aware of that when I started to reload, and I seated primers with about the same strength I used on a 24-inch pipe wrench. I thought such pressure assured the primer would stay put. It didn't take long to learn that seating the primer firmly against the bottom of the primer pocket is all that is required.

Primer pockets should be checked for more than just burned residue. After several firings, primer pockets will enlarge somewhat, and this is doubly true if maximum powder charges are used. Using a primer pocket that is .0007 oversize, say, with a primer that is .0003 undersize will invariably allow the hot gases to escape around the primer. The primer must have sufficient friction to hold it in place. A handloader can detect this when

seating a primer. That's the primary advantage of using the "feel" method for seating primers.

On most bench presses, the primer is put in a springloaded priming cup/pin assembly on the priming arm, and the arm is pushed into a slot in the shell holding ram. When the press handle is lifted, the case comes out of the sizing die and down on the priming arm cup. The cup slides down as the priming pin seats the primer in its pocket. Almost unlimited pressure can be applied against the primer with such a setup. In fact, if a handloader is over zealous, it is possible to detonate the primer, so care must be taken. Before fear strikes the heart, let me assure you that in all the years I have been working reloading press handles, I have had only one primer discharge, and that was caused by a misalignment of the priming arm. As I applied excessive pressure, the priming arm finally slipped into the hole in the shellholder and jammed the primer into the primer pocket. It was almost the same as if the primer had been struck by a firing pin. It was pure carelessness on my part.

Some reloading presses can be adjusted to control the travel of the priming pin. Hand-priming tools are set up in a similar manner. I use a Lee hand-priming tool to load for my benchrest Remington 40XB-BR 222. I screw the shellholder into the tool until the priming pin protrudes out of it far enough to seat the primer firmly when the tool handle is fully closed. I then put plastic tape around the shellholder and tool body to keep the shellholder in place. When the tool handle contacts the tool's body, the primer is seated. It's impossible to apply too much pressure.

For hunting ammo, I mostly use an RCBS automatic priming tool. Primers are released one at a time through the auto primer feed, and the leverage system is single-stage for sensitivity that allows the operator to "feel" the primer as it is seated against the bottom of the primer pocket. In reality, this is the best method. The operator should be able to feel some resistance as the primer is seated and when it contacts the bottom of the pocket. Nearly every primer has a different feel, but this can be detected through the handle of the tool being used. If a primer is hard to seat, the primer pocket should be examined. On the other hand, if it seems to drop into the pocket, the operator should check to see what the problem is. I discard cases that offer no primer resistance, regardless of how new they are. The primer can be felt sliding into the pocket, and the operator should stop when the primer makes firm contact with the bottom of the pocket. Most American primers now have a flat crown top. Years ago, primers with rounded tops also were common, and these required a concave priming post for proper seating.

When a primer is seated properly, there will be no evidence left by the

When a case separates at the head, where the web thins down to the wall, the shooter can have problems. Gas might leak back through the action, and the front portion sometimes remains in the chamber when the bolt is opened.

priming pin or punch. If excessive pressure is applied, the primer will be flattened and the curved radius from the flat crown to the sides of the primer will show a sharp ring. A well-seated primer will look exactly the same on top as it does before installation.

Primers are categorized by size, which most handloaders refer to as large and small. There are large and small rifle primers and large and small pistol primers. Rifle and pistol primers should not be interchanged. Rifle primers normally have tougher cups, a greater height, and contain more explosive mix than do pistol primers. Since handguns have a lighter firing pin blow, pistol primers are made of thinner material. The nominal diameter of a small primer (both pistol and rifle) is .175 and large rifle and pistol primers measure .210. Magnum primers contain a greater amount and perhaps a slightly different mixture than is used in standard primers. Magnum primers also burn hotter and longer. Magnum primers are normally used with slow burning powders, some ball powders, and in extreme cold temperatures. Magnum pistol primers should be used in heavy loads of hard-to-ignite slow burning powders.

Small rifle primers are used in small capacity cases such as the Hornet, Bee, 222 and 223. Large rifle primers are used in all the rest, with the exception of one or two wildcats such as the 224 CHeetah cartridge. The CHeetah case is swaged from Remington B-R brass, which is a 308 case with a small primer pocket.

Primers are potentially dangerous to handle so common sense should be used. Primers should always be kept in the boxes they come in. Just the fact that primer boxes have partitions to hold the primers in rows of ten is adequate evidence that they shouldn't be dumped in a jar or box. I like what Speer's Number 11 reloading manual says about loose primers: "Factory packaging is designed to prevent sympathetic detonation of the whole carton, should one primer be fired. If the primers are dumped in bulk, this protection is lost. Should one primer fire from friction, static electricity, or other cause, the whole mass may detonate instantly." Don't leave unused primers lying loose on the reloading bench; put them back in their original boxes.

Powder Charging, Bullet Seating and Chronographing

AT THIS POINT, the empty case has been resized and primed. If a case length gauge is available, all cases should now be checked for length. Nearly all up to date reloading manuals show recommended case length. For years, I used a vernier caliper to check case length after full length resizing. If a case has stretched considerably, either from the internal pressure created by firing or sizing, its mouth can be filed down, but the best move is to purchase a case trimmer. I believe I've trimmed well over 100,000 cases on a hand-operated Forster trimmer, and I have no idea how many have been cut and trimmed on the Forster Power Trimmer which works in conjunction with a drill press.

A deburring tool is essential in reloading. It is designed primarily to chamfer the mouth of the case for easy bullet seating without damaging the case, and to cut away tiny burrs on the outside of the case mouth. If the case is just slightly long, the deburring tool can be used as a trimmer.

If you're a meticulous handloader, you might want to clean the ouside of the case. This should be done after the case is resized. Many reloaders scoff at this, but I did it for years, and I always was proud of the appearance of my reloads. In fact, many accused me to trying to pass off factory rounds for reloaded ones.

Earlier I mentioned a machine that I built to handle a number of reloading operations, including inside neck cleaning and lubrication, primer pocket cleaning and outside case cleaning. I have no intention of trying to describe it in detail, but the machine shop that line bored the bushings for it referred to it as the Monster. It's only 16 x 8 x 10 inches, but it's built of half-inch steel plates and weighs 96 pounds, including the motor.

Shortly after getting into the reloading game, I met a chuck hunter who was using the brightest shells I have ever seen. I proudly stated that I didn't use factory loads, but had graduated, and believe me, I emphasized

"graduated," to reloaded ammo. I dug a handful of crummy looking Lewis specials from my pocket, and stated rather emphatically that handloads always looked dirty. My breath caught when the fellow told me he wouldn't touch a factory round. The bright and shiny cartridge I was holding in my hand was indeed a reload. Then, to add insult to injury, he opened his pickup's door and produced a curly maple hinged-top wooden box that glistened with varnish (the so-and-so must have been a cabinet maker) that held forty super clean rounds of ammo. The lowest blow came when he removed from his shirt pocket a neat homemade leather container that held ten beautiful reloads. He emphasized rather strongly that he never carried loose shells in his pockets. He was diplomatically putting a job on me.

I left the field a bitter handloader. It was a low point in my chuck hunting career, but I was determined to get into the shell cleaning business. That very evening I designed the Monster. It was multi-purpose, to say the least. An electric motor supplied the power, and a series of shafts, belts and pulleys activated various devices which helped me to clean the cases, including the necks inside and out, and the primer pockets. Compressed air piped to the machine is readily available to blow the residue from primer pockets and even from the case itself if necessary.

With all the cases resized, primed and cleaned, installing the powder charge and seating the bullet are the finishing opeations. But there are still a few bridges to cross. In the powder section I discussed the makeup and some basic differences between black and smokeless powders. Here we're interested only in smokeless. Smokeless powders are made in three categories — for rifles, handguns and shotguns — though there is a little overlap among some of them. For example, Hercules 2400, an excellent powder for small centerfires such as the 22 Hornet, is also useful in some handgun loads and has a few applications in shotguns, but that's a bit unusual. Smokeless powders also are available in three basic physical forms, tubular, flake or disk, and ball. Within these forms there are variations in size and shape; for instance, the balls can be flattened, which means some look like tiny holeless doughnuts. These differences affect burning rates.

Smokeless powders are usually identified by the manufacturer's (or basic supplier's) name plus either a name, a number or letters, or a combination of some of these. Thus we have, for instance, Hercules Bullseye, Winchester-Western 748, IMR-PB Shotgun, or Hodgdon HS-7. Smokeless powders differ chemically (single base powders contain nitrocellulose while double base powders contain both nitrocellulose and nitroglycerine) and physically (size and shape of powder kernels are different, and coating can be different). These variations cause differences in burning rates, and this

determines which powders are suitable for the wide assortment of cartridges, shotshells, bullet weights and shot charges on the market. Manufacturers extensively test their powders before they ever are offered to reloaders, and they and bullet makers publish tested loads showing where each powder may be used and in what amounts with given projectiles. Handgun powders usually are fine grained for easy ignition and quick burning in short barrels. Rifle powders are made in widely varying burning rates, some being fast burning for use in small capacity, light bullet combinations such as the Hornet and Bee, others being comparatively slow burning for large capacity, medium caliber loads such as the 7mm Remington and 300 Winchester Magnums. Shotgun powders also vary, depending upon their use. The same powder is not ideal for both 20-gauge woodcock and 10-gauge goose loads.

Reloading manuals list countless tested loads for all available powders, of course, and should be studied and consulted by every handloader, veteran as well as beginner. Obviously they cannot list all possible combinations of powder, bullet and primer — that would be an infinite number — but they do give enough to handle any shooting situation, so I think it's a good idea to stick with their recommendations. Such loads are based on scientifically measured pressures and velocities. Nowadays, many advanced reloaders have chronographs to measure bullet velocity, but almost no private individuals have the equipment to measure pressures, and ultimately that is the limiting factor because it determines the shooter's safety, so I believe it's advisable to work with loads from a good manual rather than edging into an area which can be exceedingly dangerous.

When handloading was going out of high gear into overdrive in the early 1950s, the ex-military powders 4895 and 4831 were by far the most used on the home level. A number of powders were available from Dupont and Hercules, but these two plus 3031 held the spotlight. I used many pounds of 3031 during the '50s and early '60s. It is similar to 4895, except that on maximum loads its charges are several grains lighter. These three powders took many of us through our formative years of reloading.

Ball powder was developed in the early '30s and used in the 30-caliber Carbine cartridge during World War II. It has been stated that ball or spherical powders (which aren't always round) have a higher flame temperature than single base propellants, because they are double base, which means they contain nitroglycerine. In a letter to a friend of mine, M. W. Millspaw of McKean, Pa., Olin Corporation stated, "Ball powder propellants definitely have a lower flame temperature than extruded propellants. These flame temperature values are derived from a calculation of chemical reactions using the Hischfelder-Sherman method which is the

In the early '60s I was using this Herter's chronograph to measure bullet velocity. Compared with today's units, it was slow and inconvenient. But it gave me answers that no other shooter in my area had.

industry standard. Also ball powder propellants have a lower flame temperature at maximum pressure, which is the most erosive time of propellant burning in the gun chamber. The reduced barrel erosion is due to the lower initial flame temperature because of the deterrent layer on ball powder propellant. The effect of nitroglycerine on flame temperature is negated by the presence of the deterrent. This is one of the reasons why 90 percent of all U.S. military ammunition from 5.56mm to 24mm, is loaded with ball powder propellant.''

I have inserted this because it is fresh information. Many reloaders have shied away from ball powders because they had been led to believe the hotter flame would erode the barrel. From a handloader's point of view, ball powder is much easier to use because it flows through a measure so easily and accurately. There is no bridging or cutting in the measure. Ball powders are harder to ignite than extruded powers, so magnum primers should be used in certain loads.

Check the reloading manual for the proper powder and suggested weight charges for the bullet you want to use. It is best to start with the lightest suggested charge and work up. The more powder, the higher the velocity — up to a point — and the higher the pressure. In many cases, better accuracy is obtained with smaller powder charges. However, never use charges lighter than those recommended in the manuals with slow burning powders such as 4831; they can cause unexplained detonations which might wreck a gun.

Setting a powder measure is a trial and error procedure and requires the use of a powder scale. Most scales have a beam which balances on a fulcrum, with a movable poise on each side. One end of the beam is graduated in grains, the other in one-tenth grains. With each poise set on zero, level the

beam by adjusting the leg in the scale's frame. Then move the poises for the desired weight charge. Always double-check the poises to make certain they are on the correct marks.

After double-checking to see that the correct powder is in the powder measure, throw several charges from the measure, returning each to the hopper, to help settle the powder in the hopper, to be sure it's flowing normally, and to get some idea how much powder is being dropped. Adjust the powder measure up or down as needed and weigh the charge. It's a matter of adjusting and weighing until the desired charge is dropped. Weigh several more charges before locking the metering adjustment on the powder measure. Until a smooth rhythm is developed, weigh every other charge. I do this on a progressive press until I'm sure the measure is throwing consistent powder charges and, even on a big run of brass, I stop every fifteen or twenty rounds to not only visually check the powder in several cases, but also to weigh them.

A powder measure is not meant to replace a scale. The two work as a team. In the early years I weighed every charge, but that is really not necessary. A close visual inspection of each charge, before the bullet is seated, will reveal any significant differences. If the powder level in one case is different from the others, weigh that charge. Volume is important, and each case should be filled to the same level. Since cases from different manufacturers often vary slightly in capacity, it's not a good idea to mix them. Stick with one brand, at least in a given batch of ammo.

Operating a powder measure is no great feat of skill but, as with the progressive reloading press, it takes considerable time to develop a smooth rhythm. Each measure has its own idiosyncrasies, and the handloader has to get the feel of the tool. Some measures have a swinging knocker attached to the main body. When a powder charge is thrown, the operator lifts the knocker and lets it drop against the measure just above the drop tube. The sharp quick blow unseats any kernels of powder that have hung up in the drum or drop tube assembly. On most measures, it's wise to bump the handle back and forth slightly, after the powder is dropped. This will loosen any powder that might be sticking. I do this faithfully on progressive loaders that do not have the powder measure built into the mechanical operation, such as some types of progressive shotgun reloading presses. Bumping the handle gently at the end of the throw helps make sure that all the powder is in the case where it belongs.

To complement my old Belding & Mull No. 28 press, I often use a Belding and Mull visible powder measure. The powder in the hopper falls into a charge reservoir, and from this into an adjustable measuring tube. The

reservoir has a glass window through which the powder is clearly visible. The graduated charge tube is inserted into the bottom of the measure and, when the handle is pushed sideways, the powder falls into the tube. With this setup, the weight of the powder in the main hopper has no bearing on the charge falling into the charge tube.

I suppose it's considered antiquated by today's standards, but I believe the Belding & Mull is one of the most reliable measures ever invented. When the handloader removes the tube from the measure, he can see the powder in the tube. If the charge tube is properly locked, there's no danger of throwing an excessive charge and, by the same token, the operator can see if the tube is completely full. Like the discontinued Belding & Mull Model 28 press, the B & M visible powder measure is simplicity at its best.

When all the cases are charged with powder and have been visibly examined, the next step it to seat the bullet. To some reloaders and many shooters, bullet seating is the most important step in the assembly of a reloaded cartridge. I won't go that far, but bullet seating is probably more important than many reloaders think. It is not just a matter of stuffing a bullet into the mouth of a primed and charged case; it's a bit more complex than that.

Screw the seating die into the tool unitl its mouth is about 1/8 inch above the shellholder when the ram is up as far as it will go. The bottom of the die should not quite touch the shellholder. Holding the die so it can't move, screw the lock ring down against the press and tighten it. Loosen the lock nut or nuts on top of the seating die and unscrew the seating rod far enough that it can't seat the bullet deeply. Place a bullet in the mouth of a charged case and shove it gently into the seating die. You will be able to feel the bullet contacting the seating stem. When the press handle is at the far end of its throw, remove the cartridge and compare its overall length with a factory round or check it against the measurement shown in a reloading manual.

This is a trial and error operation. I seat the first bullet in steps, which means I don't move the press handle as far as it will go. I check the length of the cartridge two or three times. If the bullet is not seated deeply enough, loosen the lock ring on the seating stem and screw the stem down a turn or two. RCBS says that one full 360-degree turn of the seating stem moves it .0357.

The ideal seating of a bullet is to have its base even with the bottom of the neck and its ogive (the curve or taper ahead of the bearing surface) almost touching the lands. This usually gives excellent results as it starts the bullet off in good alignment with the bore and at the same time gives maximum powder capacity. Many varmint shooters, who tend to single load their rifles,

use this technique. But it's not hard see that this setup is possible with only one or two styles and weights of bullets. The same weight and shape of bullet that fits to the nth degree in one chamber may not properly fit the chamber of another rifle even of the same make, model and chambering. Bullet seating is mating the cartridge to the chamber of each rifle.

Some top shooters want the bullet to touch the lands and grooves ever so lightly. This method can be used with any weight and style of bullet, so long as there's no restriction on overall cartridge length, and this is the reason it has a large following. I am not finding fault with this but, in hunting rifles, there are other factors to consider. The length of the magazine in a bolt, auto, pump and some lever actions has to be taken into consideration if the rifle is to be used as a repeater. I once met a fellow who was using a Savage 99C chambered for the 308 cartridge. He had switched from 150-grain bullets to 165-grain spitzers, and zeroed the rifle by feeding one shell at a time into the chamber. He was a long distance from home and a quarter-mile into the woods when he discovered the spitzer bullets were seated too long for the detachable magazine. This turned his fine lever action Savage into a single shot. It's vitally important that cartridges to be used in big game rifles fit normally into the magazine. I like to load them to the maximum length possible so long as they will still work through the magazine and the bullet will not stick in the chamber if the cartridge is removed unfired. Normally that is no problem with magazine-length loads; it can be with cartridges intended for single loading.

Chamber pressure varies with different seating depths. If a bullet is deep enough in the case that it can move freely for some distance as soon as the powder ignites — a more or less normal situation — pressures will be normal too. But if the bullet is seated tightly into the lands, its initial resistance to movement is significantly greater and pressure builds quickly.

Some top shooters claim, and I'm prone to agree with them, that many rifles, especially competitive outfits, are more accurate when the bullet is seated to touch the rifling. This is true in my Remington 40XB-BR 222 and several varmint outfits, but I cut the powder charge several grains to accommodate for it. That's the only alternative a handloader has to prevent high chamber pressures.

After the bullet is seated, the cartridge is ready to shoot. Both anticipation and apprehension are wrapped up in the first fully reloaded round. It's a moment to remember, and I've known of new handloaders who mounted their first loaded round on a plaque for a souvenir. I'll be honest; I didn't mount my first shell on a mahogany board. My apprehensions and doubts didn't subside until my first reloaded round cut a clean hole in the target.

When four more formed a neat 1-inch group, I was satisifed that assembling handloaded ammunition was not beyond the physical or mental capabilities of an average shooter like myself. It was indeed a milestone in my hunting and shooting career.

There's no doubt that the new handloader will add a variety of tools and equipment as time passes. I have mentioned some items such as a case trimmer, case gauge, case tumbler for cleaning, primer tray, and neck expander. The list could go on indefinitely. Some are incidental pieces of reloading gear, while others such as a chronograph are major investments.

"Is a chronograph beneficial to the handloader? Is there any real value in knowing the actual velocities of my reloads?" These are questions I have answered dozens of times through the mail, over the phone and at gun seminars. I could give an affirmative answer and let it go at that, but a chronograph's importance is not fully understood by many handloaders so maybe it should be discussed. A chronograph's paramount purpose is to tell the user what velocity a given load delivers from his rifle. It can be his own handload or a friend's, a factory load, whatever. He wants to know this because it lets him calculate the energy of that particular combination of powder and bullet, and gives him some idea of how flat the bullet's path will be over his normal hunting ranges, which lets him compare the load with all others. The trajectory will be affected by such things as the bullet's ballistic coefficient and the scope's height above the bore, but that's true of all loads, so knowing velocity is a prerequisite for everything. A chronograph, incidentally, does not measure muzzle velocity, though that normally is the term used when basic muzzle speed is mentioned. There is no way to measure muzzle velocity — the bullet's speed at the moment it exits from the bore — as velocity is determined by measuring the elapsed time of a bullet's flight over a precisely measured distance. Therefore it has to travel so many feet or yards to be measured. A chronograph normally measures what is called instrumental velocity. This is done by firing a bullet over or through two units, the first of which activates the chronograph, the second of which stops it. The first unit has to be at least several feet in front of the muzzle, say 5, to prevent blast from giving a false starting impulse. The second unit is some convenient distance ahead of the first, say 10 feet. The bullet's average velocity over the precisely measured distance between the start and stop units is assumed to be at the midpoint of the 10-foot separation, or the 5-foot mark. This, plus the 5-foot distance between the muzzle and the starting unit, gives a distance of 10 feet for the point at which instrumental velocity is taken. Actual muzzle velocity can be closely calculated if the bullet's ballistic coefficient is known, by figuring the velocity loss while the bullet travels the

first 10 feet, but it isn't enough to be significant to most shooters so tends to be ignored.

Over the years, I have used many chronographs, and three that I have had close association with are a Herter's, an Avtron K233, and an Oehler 32/61 Chronotach Skyscreen System. The Herter's instrument that I started with was accurate, but it had problems deriving from its metal screens and poorly designed alligator clips on the screen's connecting cables. The screens had the appearance of regular screen door wire, except that a continuous wire was woven through grids in each screen. When a bullet cut the continuous wire in the first screen it started the counting sequence; when it cut the continuous wire in the second screen, the instrument stopped counting and a series of numbers was illuminated on the instrument's top panel. The figures were added, and checked against a table to obtain the velocity reading.

I shot many hundreds of rounds through the Herter's wire-type screens, but results were erratic. It was next to impossible to get a solid hookup on the screens. Consequently, the readings were incorrect or didn't show at all.

I struggled along with the Herter's for several years, and then purchased an Avtron K233. The Avtron used plastic screen with a continuous metallic paint line zigzagging back and forth across it. It operated exactly as did the Herter's. The bullet broke the painted line and the instrument started counting. The K233 used a digital readout that was checked against a table to get the correct velocity reading. The Avtron was very dependable. I used it

With today's chronographs, doing the shooting and getting accurate data is the easy part; the time consuming part is carefully preparing the loads to be tested.

for a number of years, but was forced to retire it when Avtron stopped making chronographs and screens.

I have been using an Oehler Model 32/61 Chronotach/Skyscreens System since the mid-'70s. It consists of a main computer and two skyscreen boxes. (The Model 32 has been replaced by the Model 33, using Skyscreen III Detectors. With the new setup, you shoot through the detectors; I'll delve into that a little later.)

The old Model 32 is simple to operate. Just set the skyscreens at the desired spacing, hook up the cable from each skyscreen to the main computer on the benchrest, and start shooting over the skyscreens. The computed velocity is shown a single digit at a time in actual feet per second. No resetting is necessary. Shoot, wait approximately seven seconds for the digital readout to appear, copy it, and shoot again. The digital counter doesn't stop until the instrument is shut off or another shot fired. There's no chance of losing a reading.

The Model 32 Oehler has never failed me, except when a bullet was fired too high above the skyscreens. I try to stay about five inches above the skyscreens. Some care has to be used. Normal scope height is 1½ inches above the barrel, so the crosswire must be held 6½ inches above the skyscreens. I aim at a piece of red engineering tape placed seven inches above the skyscreen. During many years of use, the front skyscreen was struck only one time, and that was with a ball from a muzzleloading outfit.

The Oehler Model 33 is more advanced than their Model 32. The Model 33 instantaneously displays either velocity in feet per second or time in microseconds on the LED display. It automatically resets itself immediately after the round is fired, but the velocity readout and shot number remain displayed until the next round is fired. The Model 33's most impressive feature, to me, is the automatic reset and statistical summary, which allows a complete series of test shots (up to 255) without touching the chronograph or writing down a single number. At the end of the test, touching the Summary button displays the lowest velocity with LO in the round number position. Touching Summary again displays the highest velocity, shown in HI. The third touch brings the extreme spread of the velocities, shown as ES, and the fourth touch shows the average velocity of the test, indicated by an A. A final touch reads out the standard deviation of the velocities with an indicated SD. The unit will cycle through the system as many times as needed.

Skyscreen III detectors are actually triangles 12 inches wide at the top and 13 inches high. This gives the shooter a generous area to fire through, and the detectors don't have to be 10 feet apart. With a little ingenuity, they can be set up smack in front of the benchrest, and chronographing can be done while

firing for accuracy. The now-discontinued Model 32/61 Oehler system certainly made a major contribution to my handloading education. The Model 33 is far more sophisticated, and will meet all the requirements of the most demanding handloader or shooter. My scratched and battered Model 32 is still functioning flawlessly, and there's no question it is vastly superior to the ancient Herter's, but it was the Herter's that took me through the formative stages of handloading and range testing, so I owe it a great deal.

Yes, I do believe the serious handloader needs a reliable chronograph. How else will he know how his loads are actually performing? Reloading can produce ammunition that will develop the full potential of your rifles. With commercial ammo you shoot what the factory loads for a particular cartridge. (You also assume it is delivering the velocity listed in published tables, but a chronograph can supply some interesting facts in this regards too.) The handloader is not limited to what others supply him. He can work up an infinite variety of loads if he wants to.

Yet, there's no point in working up new loads, or slight variations of suggested loads, if there is no way to find out how they react. No ballistician can accurately predict how a certain load will perform in your rifle. Approximations can be made, but there are no guarantees that the performance of a given load in one rifle will be the same in another rifle of the same chambering. It often varies significantly.

A serious handloader should know the velocity of every primer/powder/bullet combination fired in his rifle. As stated, a bullet's velocity directly affects its energy, and velocity, to a great extent, determines the trajectory of a bullet. It's generally agreed that it takes approximately a 5 percent gain or loss of velocity to make a significant impact on the bullet's path. This would equal roughly 140 fps with a 150-grain 308 bullet that leave the muzzle at 2800 fps. A loss of 140 fps could mean the difference between a hit or miss at ranges beyond 250 yards, with conventional zeroing. You might wonder if a loss of 140 fps is possible without making a profound change in the powder charge. Many handloaders do not think so, because they have no way of knowing, and that is the number one reason for the chronograph to be a part of the handloader's equipment.

For many years, the velocity figures listed in factory ballistic tables were taken from long barrels, and long rifle barrels give higher velocity readings than short barrels. The problem here is, there aren't many deer rifles with 26-inch or longer barrels. It's next to impossible for a handloader, testing his loads in a 20-inch barrel such as Marlin's 336CS or the Model Seven Remington's 18½-inch barrel, to get the same velocity readings that came from a 26-inch barrel.

Here's a perfect example that I encountered several years ago. My deer-hunting friend Bill Nichols loaded several boxes of Remington 7mm Magnums for a mule deer hunt in Wyoming. Bill had an injured right shoulder at the time, so reduced his load to 60 grains of 4831, which the manual said would give a muzzle velocity of 2800 fps with a 160-grain bullet. However, Bill wanted to be certain, so he and I chronographed his reloads, along with Remington's 150-grain soft point factory loads, in his Sako's 23-inch barrel.

Bill was disappointed to learn that his loads had an average velocity of only 2584 at 15 feet from the muzzle. Going up to 64 grains of 4831 increased the average reading to 2764 fps — still a bit short of the 2800 fps listed for a 60-grain charge of 4831. I checked several other manuals, and all gave the 160/162-grain 284-caliber spitzer bullet a muzzle velocity of 2800 fps or more with 60 to 62-grains of 4831. It may be a surprise to learn that the 150-grain factory load, which is listed at 3100 fps, from Bill's rifle averaged 2874 at 15 feet.

There's quite a difference between the velocity figures shown in Bill's reloading manual and those measured by the Oehler Chronotach. I have seen this often. It's unusual for handloaded ammunition to produce the velocities shown in various manuals, although most of these are obtained with conventional length barrels. Many times the figures are close but, from what I have seen, they tend to fall short of published data.

When I started chronographing, I fired 10-shot tests. I cut back to 5, and then to 3. But I'd better qualify why I did this. I stick with 3 shots only as long as the readings are rather consistent. If the three readings are 2845, 2873 and 2830, that's only a 43-fps spread from the top to the bottom. It also gives a 2849 average velocity at 15 feet from the muzzle. That's acceptable consistency. However, if the readings were 2845, 2955 and 2888, which shows a spread of 110 fps, I would shoot several more rounds. If the readings fell back to the 2860 range, this would indicate the 2955 fps shot was a fluke. If the readings kept jumping back and forth, I would take a deeper look at the load being used, and possibly abandon it.

Many handloaders make high velocity their top requirement in a reload. That's a mistake. For a bullet to reach a distant target and offer reasonable expansion, it obviously has to be driven at a fairly high velocity, but just going for sheer speed is defeating the purpose of handloading and could be dangerous as chamber pressures rise when velocity is increased. Other problems, less serious, often accompany top velocity loads. For your particular rifle, there is an acceptable range of velocities with the primer/powder/bullet combination you are using, and best results will come if you

stay within these parameters. The chronograph will help determine which velocity gives the best results.

In normal chronographing I am basically interested in the average velocity for three shots. This is not the proper approach when working up a load or testing a new combination. I then fire longer strings. One reason for this is that, over a long string, it's possible for two velocity groups to appear. In other words, one group, say six shots, might average 2850 fps, while the remaining four can come out at 2760. That's a 90 fps difference. That's reason enough to be suspicious. Something is wrong, and further tests are necessary.

In all the years I've been firing over chronograph screens, I have never seen even 3 consecutive shots produce the same velocity reading, to say nothing of 5 or 10. The closest I can recall was a 5-shot test with a 30-06 that produced a 7 fps spread. That's close. I feel a 65 fps spread is the maximum acceptable in a 5- or 10-shot test, with either handloads or factory ammunition. I just chronographed some Remington 140-grain 7mm-08 factory cartridges, which produced a 27 fps spread for 3 shots. That shows consistency.

In time, handloading becomes somewhat of a science to the serious reloading fan. With these shooters, handloading is not just a matter of putting a primer, powder charge and bullet in a case. It reaches beyond that. Handloading becomes a research project. The quest for accuracy from new combinations requires experimenting, and experimenting requires a logical approach and accurate record keeping. There's no point in going all out to develop new load combinations if accurate records aren't kept on every test. I have gone so far as to have a chronograph data form printed on sheets of thin cardboard. They fit nicely in a 3-ring binder, for permanent filing.

Handloading is an option for every shooter and hunter. The reloading equipment can be anything from a single stage press such as the RCBS Special-3 through the powerful Lyman T-Mag Turret to the more sophisticated progressive metallic reloading presses such as the Hornady Pro-Jector, RCBS 4 x 4, Lee Pro 1000 or the Dillon RL550B. There is no shortage of top quality reloading equipment today, but I want to reiterate that quality reloads come primarily from old Homo sapiens himself. Good equipment is important, but it's secondary to the man or woman operating the press handle. That's the truth.

Thoughts On Metallic Progressive Presses

FOR A NUMBER of years there was a feeling that making automated or progressive presses for metallic cartridges was not feasible. I can't give a definitive reason why this feeling prevailed. It might have stemmed from the numerous complexities inevitable in making such a press, or it could have been felt that metallic cartridge reloading was too risky for a production-type setup. A lot of emphasis was placed on meticulously doing each step, and I know that in the early stages of the reloading game after World War II a great deal of emphasis was placed on properly seating primers and weighing each powder charge. Dumping directly from a powder measure was not in vogue.

Reloading presses were basically simple "C" types. They were far from complicated, and installing an indexing mechanism for turning the shellplate and getting linkage to the powder measure posed problems the designers of home reloading presses apparently were not ready to face at that time. Personally, I think there was not as much need for a metallic cartridge progressive press as there was for an automated shotshell reloader. Trap and skeet shooters fire hundreds of rounds a week compared to the box or two of metallic cartridges used by a varmint hunter. Progressive presses are more suited for competitive handgun shooters or clubs where thousands of shells of the same caliber are loaded in a given session. In fact, the first progressive metallic cartridge presses I knew about were designed for straightwall handgun cartridges.

The manually operated turret press was as close to automation as the average handloader of the 1950s felt possible. I had a Model 234 Herter's Turret press with a six-station turret. The idea was to leave the shell case in the shellholder in the ram and move the turret after the resizing/decapping/priming operation was completed so the powder measure would be over the

case. Pushing down on the handle moved the case into the tube of the powder measure. The powder was dropped and the turret moved so the bullet seating die was over the charged case. A bullet was inserted in the case mouth and the press handle pushed down to complete the loaded round.

This was highly advertised as "progressive," but I found it to be a lot of work. I tried this for a few boxes, but it wasn't long until I processed all my cases at one station, and then moved to the next. That was progressive enough for me. I did spend a lot of time trying to come up with an automated press, but there were just too many hidden problems.

Today there are a number of good progressive tools. I use Hornady and RCBS presses. They are not fully automated. The operator has to place an empty in the shellholder and seat a bullet on the charged cases's mouth. However, once the operation is underway, each push of the handle produces a loaded round. Each press has a "kicker" that knocks the loaded round out of the shellholder and into a plastic container. Both presses are self-indexing when the handle is pushed down. The powder measure's handle is hooked to a linkage that lifts it when the ram is raised. With these two presses, loading boils down to a three-step operation — place an empty, start a bullet in the charged case, and push the press handle down.

For the competitive shooter, a progressive press will cut reloading time in half or better. It is designed for production-type reloading. On the other side of the ledger, the shooter who reloads ordinary amounts of ammo for several rifles will be better off with a single stage press. The progressive offers speed, but it must be watched carefully. If a mixup occurs, the entire operation has to be shut down. If the operator fails to place an empty, or if the primer tube or powder measure runs dry without being detected, there's a real problem. It can be frustrating.

Nevertheless, I disagree with those who claim a progressive press is for only the experienced reloader. I believe any conscientious handloader can master one. My conservative feelings are not due to the press's complexities, but rather hinge on whether there is a need for a production-type press. From April to October, a competitive handgunner I know fires several hundred rounds a week with a 357 Magnum. On a single stage reloading press, it would take several hours each week to crank out that much ammo. He has a Hornady Projector set up, and that's all it's used for. But that's reason enough to have it. Once a week, he spends a half-hour or so reloading his 357 cases. He uses an RCBS Rock Chucker for other handguns and rifle reloads. This shooter burns a lot of ammo, and the progressive press is exactly what he needs.

Shotshell Reloading

IT'S SURPRISING THE number of rifle reloading fans who have not taken up shotshell reloading. There's a mistaken belief that shotshell reloading is just for trap and skeet shooters. If that were true, then rifle reloading would be for only benchrest and other competitive shooters. The truth is that shotshell reloading can be just as important to the small game hunter as metallic cartridge reloading is to the rifle and handgun hunter.

I have been asked if shotshell reloading is more complicated than cartridge reloading. I can't say it's more complicated but it does require the same amount of caution and care; the operator must pay strict attention to every detail.

Before heading down the reloading road, it is wise to do some research. The *Hodgdon Data Manual,* 25th edition, gives step by step reloading operations for both rifle cartridges and shotshells. *Reloading for Shotguns* (DBI Books, Inc.), edited by Robert S.L. Anderson and written by some of the nation's most qualified handloaders, covers every aspect of shotshell reloading in great detail. This one of the most thorough manuals ever offered on shotshell reloading.

There are more progressive types of shotshell reloading presses than there are rifle types. This may lead the beginner to think a progressive press is the proper starting tool. To the contrary, the progressive shotshell press, like the progressive rifle reloading press, is basically for the competitive shooter. All progressive presses are designed to turn out huge amounts of ammo. The skeet or trap shooter who burns 500 rounds or more a week certainly needs a reloading tool designed for bulk loading. But the beginning shotshell handloader should start with simple, easy to understand reloading tools. I explained this in the chapter on metallic cartridge reloading, and it's just as true with the shotshell novice. The complexities of any type of reloading must be analyzed step by step.

A good selection of starting presses is available today, including the Hornady 105, MEC 600 Jr. Mark 5, Bear Honey Bear, Ponsness-Warren Du-O-Matic 375, and the Lee Load-All II. I have several progressive shotshell reloaders in my shop, but I still crank out most of my 20-gauge hunting loads on a Lee Load-All press. I like to load my hunting ammo a few rounds at a time. There's no need for high speed or mass production, and the Lee Load-All gives me exactly what I want.

In rifle and handgun reloading, various die sets can be used for different cartridges. A powder measure is adjusted to throw a given weight of powder, and this should always be set up by using a scale. In shotshell reloading, powder and shot charge weights are determined by bushings inserted in the charging bar. Each manufacturer uses a somewhat different approach, but usually a variety of powder and shot bushings can be installed to give the correct weight of powder and shot. This is a crucial point in setting up a shotshell press, and the operator must make certain the correct bushings are used. Bushings are identified by number or letter, and a chart which comes with the press lists the various powders and how much a certain bushing holds. The same bushing can be used for many types of shotshell powders, but it will hold different weights of each because they have different densities.

Powder bushings hold close to the weight shown on the powder chart, but it's wise to weigh a charge before starting to reload. There can be differences, and another bushing might have to be used. I never ream out a bushing; that's playing with danger. I have inserted a tiny piece of plastic tape in a bushing that was throwing a slight overcharge of powder. Double check the bushing number against the one suggested on the powder chart. All powder bushings for a given tool have the same outside diameter; it's the inside diameter that is different. Normally, shot bushings have a larger outside diameter, which prevents them being used as powder bushings. In some cases, powder bushings are made of aluminum and shot bushings of steel.

The normal four steps in loading rifle cartridges are resizing/decapping, priming, dumping the powder charge and seating a bullet. In shotshell reloading, there are usually five major steps on most tools. Resizing/decapping is the first step, primer seating the second, and dumping powder, inserting a wad, and adding shot are done at the third stage. A crimp starter die is used at the fourth step, and final crimping is the last.

I won't try to describe in detail how each operation works; it's wiser to follow your press's operating manual as different makes of presses operate in different ways. The basic functons are similar, but each press uses a slightly different approach.

Shotshell presses range from simple hand tools to progressive models such as this Ponsness-Warren Size-O-Matic 800B which can easily produce a case of shells per hour. But it's not necessary to have a super sophisticated press to produce excellent handloads. Quality depends more on the operator than the tool.

There is one cardinal rule I stick with religiously: I use the exact components suggested in the reloading manual. In shotshell reloading, components, including the case, should not be switched or substituted. Shotshell reloading demands an exact mating of components.

A shotshell primer doesn't vary much from a metallic cartridge primer in design. However, a shotshell primer is not supported in a primer pocket, as is a rifle primer. There's no primer pocket bottom for it to rest against. The shotshell primer is equipped with its own supporting cup which has a flange on top. The brass head on the case is relieved slightly for this flange to fit in to. The anvil fits inside the cup.

Shotshell primers look pretty much the same, and their basic parts are similar, but their influence on the total charge is different. It is mandatory for a shotshell primer to be compatible with the other components being used. It's wise to always use primers that have covered flash holes. Some types of powder, especially ball powder, can dribble into the primer through an open flash hole and have an effect on ignition.

Some shotguns have relatively short firing pins, which makes primer seating in the shotshell a critical step. Be careful not to seat the primer too deeply. This can cause misfires in shotguns with short firing pins. This might come about if a Winchester primer is used in a Remington case, say.

I have been told that a wad is a wad, and as long as it holds the shot charge, there's nothing to worry about. Don't believe that. The wad should fit the case's interior to the nth degree. Many reloaders are not aware that some shotshell hulls have tapered interiors which make the sidewalls thicker at the base. Other brands have cylindrical interiors. It's easy to see that a tapered wad will be loose in a cylindrical case, which might permit the powder to mix with the shot charge and, conversely, a non-tapered wad might not seat properly on the powder charge in a tapered case. Use the wad listed in the reloading manual for a given case and load. Any change is bound

to influence chamber pressure, and the wrong wad will be detrimental in getting a solid, flat crimp. A proper crimp is mandatory in shotshell reloading. Don't overlook this. It might come as a surprise, but plastic wads increase the efficiency of burning powder which, in turn, increases chamber pressure by as much as 25 percent. This single fact shows the danger in switching components. Finally, the wad determines to some extent the outcome of the final crimp. Wads that are too short will allow the crimp to cave in, and too-long wads will produce a bulged crimp. There should be roughly 7/16-inch of space above the shot charge for crimping.

The crimp is not just the final step, but an important one. An improperly crimped shell can pop open or have a ridge around the crimp that will not allow it to feed through an autoloader. Or it can be so weak it will cause sporadic ignition. The crimp must supply resistance to allow the powder burn curve to develop. The crimp should not be under undue pressure, but it should be closed firmly on top of the shot charge. I like to countersink or indent the crimp about 3/32-inch deep, but this is purely a personal matter.

I prefer to have the crimp's sidewalls straight, with the crimp segments lying flat on top of the shot charge. If the segments are high or low in the center, I double-check the wad, but the problem can be with the shot bushing. I earlier suggested checking both the powder and shot bushings for accuracy. I have found that bushings do not always throw the exact weight stated on the data sheet. I recall a shot bushing that was supposed to drop 1 1/4 ounces of shot. Using the exact components listed in the reloading manual, I kept getting a bulged crimp. Now, I had checked the powder bushing but had not checked the shot bushing. To my surprise, it was dropping about 573 grains of shot, which is approximately 26 grains over the 547 grains in a 1 1/4-ounce shot charge. In this case, it was number 7 1/2-shot, and 26 grains of weight equalled roughly 25 pellets. This might seem insignificant, but those extra 25 pellets took up some of the space needed for the flat crimp I like to put on every shotshell. I solved the problem by sticking a small peice of electrical tape on the inside wall of the bushing to reduce its volume. Naturally, this was a trial and error job, until I got the right amount of tape in the bushing.

The fired case is the key to all data, and the shotshell handloader must be able to identify the specific case he wants to use. Basically, there are two types of shotshell cases on the market now — paper base and plastic base. A paper base is any case, either paper or plastic, that has a paper base inside. Paper base cases usually require greater powder charges to obtain a given load than plastic cases, according to Hodgdon's manual. A plastic base case is one with a plastic base inside. The plastic may be an insert or the case may be a one-

piece compression-formed molding. Less powder is needed in these to obtain maximum pressures. Never interchange data between plastic base and paper base cases. Using data for a paper base case in a plastic base case can be dangerous.

All shotshell cases, even those of the same gauge and manufacture, are not constructed in the same manner, nor are they always made of the same materials. There are significant differences in the inside dimensions and base wad contour among various brands and types. Inside dimensions are important because they govern the volume of the case, which is critical to the safety and performance of the finished round. Getting back to what I said about using the exact components suggested in a reloading manual, it's important to remember each of these loads was developed for use in a specific shotshell case and its equally specific volume. Never forget the cardinal rule which states that you can't mix cases of different brands and types and expect to reload them successfully with the same primers, wads and powders.

Don't be fooled by the terms "high brass" and "low brass" in relation to shotshells. Despite common belief on the subject, high brass does not necessarily mean high power, though as a youngster I — and everyone I knew — believed that. Low brass (for low power) in the modified barrel, and high brass (for high power) in the full choke barrel was the standard setup for every double barrel user in the days of the Great Depression. How wrong we were, but that's what we believed. Some hunters still believe this, but it's not true. Actually, the height of the brass means very little, and has nothing to do with the kind of load the shell will take or how strong the case is.

Weight of shot is easy to understand, as it's listed in ounces, but most powder charges shown on shotshell boxes are still referred to as "dram equivalent." This is still a mystery to many hunters. Actually, a dram is a unit of weight which equals 0.0625 ounces. It was the common unit when black powder was used in shotshells. During the transition from black to smokeless powder, manufacturers referred to smokeless charges in the old terms so hunters could easily relate to the new ammunition. Thus, enough smokeless powder was loaded to give the shot charge a velocity equivalent to that created by so many drams of black powder, no matter what its actual weight was. That's still the practice today, though for the life of me I can't figure out why. In all fairness to shotshell manufacturers, it's possible they still use the old system as a safety measure, and to prevent reloaders from trying to duplicate their loads.

However, the paramount goal in shotshell reloading is to duplicate the performances of factory loads that have given good field results. It's possible

we can duplicate factory velocities — many handloaders have chronographs and can measure velocity — but we are never sure how much chamber pressure is being generated by our loads. Factory ammo is assembled to rigidly controlled standards. On top of this, ammunition manufacturers work with their own components, or ones made exactly to their specifications. They are able to maintain complete and precise control over every aspect of shotshell assembly, and they are always working with new cases, not ones that have been fired several times. These are important reasons for always following industry-recommended loads precisely.

Good advice to the beginning shotshell reloader is to start simple. Forget about the progressive presses and all the accoutrements available to speed up the reloading process. Learn step by step, and stick with one type of case, one type of powder, and one brand of primer.

Don't experiment in shotshell reloading. Concocting a load on your own is flirting with danger, and that should be spelled with a capital D. I have many years of experience in this field, but I still follow the manual. I can't forget that I have been allocated only two hands, two eyes and one face. They are irreplaceable. It would be ludicrous for me to ignore the advice of chemists, mathematicians, and ballistic experts who have the knowledge and equipment to determine how a shotshell reacts when fired. There is no way I can determine the flame temperature of a powder burn or what the chamber pressure rises to. My best bet is to follow their advice.

Load combinations suggested in the manuals are more than adequate to meet any hunter's needs. The belief that reloaded ammunition, both shotshell and rifle, must have higher velocities and produce more kinetic energy than factory shells is preposterous.

Several times I have stated that reloading it not primarily a means for saving money. Don't reload to save money; reload to shoot. Over a period of time the results on the patterning sheets will show conclusively how your particular shotgun handles certain loads. You can't learn unless you shoot. This may sound off course, but you will never become a good wingshot by just hunting. There aren't enough shooting opportunities. You'll be more proficient in the grouse coverts and rabbit patches if you spend some time developing loads that give good patterns and then breaking claybirds.

When you become proficient enough to produce good reliable shotshell ammo, reloading is not only good sense from a financial angle but also psychologically satisfying. Getting the exact load combination is just as necessary in shotshell reloading as in reloading rifle cartridges; in the final analysis, you can create a reload tailored for your shotgun, not one produced by a factory.

All data and references given so far refer to lead shot. Lead shot and steel shot require totally different powder and wad setups. You can't simply substitute steel shot for lead on a given load. That can cause pressures to rise astronomically. A steel shot load has its own requirements, and they are vastly different from those of a lead. You can't even use the same reloading press for steel shot, unless it was retrofitted for steel shot components. Literally everything is different. Slower burning powders are used with steel shot to keep pressures down. A vastly different shot cup is used. In lead shot, the cup protects the shot charge, but with steel shot that cup protects the bore.

Early in the transition from lead to steel in waterfowl loads, it was generally believed that steel shot could not be reloaded on the home level. That isn't true, but steel brings many problems, even for experienced reloaders. For example, steel shot hardness is measured by a diamond pyramid hardness (DPH) formula. Hardness above 90 DPH is considered unsafe to use. Peening or blasting shot, air rifle pellets, ball bearings and what is known as "soft steel balls," are far above the 90 mark and are dangerous, even if a proper steel shot wad is used. There is no truth in the belief that it doesn't matter how hard steel shot is as long as it is contained in a properly designed steel shot wad.

Steel shot loads are far more critical than lead. There is no room for error. Steel shot is now being loaded on the home level, but it's still in its infancy. It must be approached cautiously. Not all steel shot being advertised meets the industry standard of 90 DPH or less. Anyone interested in loading steel shot should study all available information from reliable sources and keep up with the subject. One good source of information is Non-Toxic Components, Inc., P.O. Box 4202, Portland, Oregon 97208. I have used Non-Toxic Components' data and steel shot with the MEC 77 Sizemaster retrofitted for steel shot, and I followed the instructions implicity. From a safety point of view, both to the shooter and the shotgun, I caution handloaders of steel shot to exercise great care and to work with reputable companies. Don't attempt steel shot reloading without the proper equipment and loading data from reputable manufacturers. Don't use any type of steel shot unless you are absolutely sure it is 90 DPH or lower. Using steel shot of a higher DPH can badly damage a barrel and perhaps cause serious injury to the shooter.

Shotshell reloading is just as much fun for the hunter as the competitive shooter. In fact, it may be more so. When you drop a rooster or tumble a rabbit with one of your own loads, it adds a new dimension to hunting. I can't describe the feeling that will race through your body. You'll have to take up shotshell reloading to know what I mean.

Afterthoughts

WHEN I WAS asked to write this book, I said, "Sure, no problem." Now, almost two years later, I can tell you a book as comprehensive as this one is nothing but problems. Fiction writing is one thing; writing factual stuff is another. They are 180 degrees apart. A novelist can say most anything he wants, but that's not true in this type of book. Everything must be verified, and some things must be checked against half a dozen references. And still there is a possibility of error.

When I started the book, I had a fairly detailed outline, but I couldn't adhere to it religiously because during the 19 months of writing, new cartridges came on the scene and other important things took place. One I can think of is the Cellini Stabilizer System, a muzzle attachment installed by Francesca, Inc., in San Antonio, Texas. Its main purpose is to reduce muzzle whip during firing. It does that very effectively, and also reduces recoil approximately 50 percent. In chronograph and accuracy tests with the Remington 8mm Magnum, Remington 7mm-08, and a Ruger Redhawk 44 Magnum, there was no significant loss of velocity (approximately 20 fps with the 8mm Mag) nor was accuracy impaired. The only drawback I found was increased muzzle blast.

Another subject of interest to some shooters — one we haven't really touched on in this book — is engraving. Engraving is an art. Many shooters make stocks for their favorite rifles or shotguns, but only the daring try metal engraving. Engraving calls for flawless work. You can usually sand out a stock mistake or fill it with fiberglass, but an improper cut in the barrel or receiver is almost impossible to erase.

George Freed of Dover, New Jersey, is an articulate engraver. His brochure states that he engraves only stainless steel, which won't rust and will last for centuries. He calls his favorite type of engraving "My Tomb

Vito Cellini and I discuss one of the stabilizers he has designed and produced to eliminate muzzle whip and reduce recoil significantly. This one is for the T/C Contender barreled for the 45-70 cartridge. I shot it. It works.

Stone." It's a message on a firearm that can be read by generations to come. He claims it's a message to posterity. Centuries after the gun owner has passed from the scene, his words engraved in stainless steel will reveal a philosophy from a long gone era. Freed feels that once your words are engraved in stainless gun steel, you become a part of history. I like that.

My friend Ted Curtis, former marketing director for Kimber, is now associated with Accurate Arms Company, Inc., distributor for Accurate Smokeless Powders. Ted sent several pounds of rifle and pistol powder for testing after I wrapped up the book. It is interesting to note in the reloading manual which accompanied them, that pressure readings are not shown. "The reason is that many reloaders seem to think there is a direct relationship between charge weights and pressures that can easily be figured out on a pocket calculator. Such is not the case. A simple change in seating depth can have a tremendous effect on pressures generated by a given set of components. In the interest of safety, we decided not to contribute to the confusion." Ted tells me the new Accurate Smokeless Powders are helping shooters win matches in practically every shooting discipline.

I'm a strong advocate for mounting a scope as low as possible, so it's reasonable to assume I'm not particularly impressed by see-through mounts. It's not that they don't work; on the contrary, such mounts can allow instant use of the rifle's open sight arrangement. But the see-through mount positions the scope high above the receiver. It forces the shooter to lift his head an inch or so to use the scope. This puts the head in a comparatively unsupported position to use the main sighting device. This is defeating the purpose. Secondly, many modern rifles have high combs to facilitate scope use, and it's almost impossible to shove the face far enough down on the stock to see through the mount bases and use the open sights. And when the

CHRONOGRAPH Model 35P Oehler
Skyscreens Skyscreens III
Velocity reading at 12 feet

TEN SHOT TEST
by Don Lewis

Hornady Frontier Factory 22-250 ammo. 53-grain Hollow Point Bullet. Fired in: Ruger No. 1 26-inch heavy barrel.

PRIMARY READING	PROOF READING
3631	3611
3642	3623
3630	3608
3629	3608
3647	3624
3632	3611
3619	3597
3631	3611
3627	3608
3615	3593

3647	High Reading
3615	Low Reading
32	Spread
3630	Average Velocity
9	Standard Deviation

cheek is shoved that hard on the comb, recoil can bruise it.

The Millett Scope-Site mount uses a different approach. Scope-Site provides open sights above the telescope. They are integral parts of the scope rings. In other words, the open sights are on top of the scope rings. I like the idea as it allows the scope to be mounted low on the receiver so the face can rest firmly on the stock when aiming with the scope. If it is necessary to use the open sights, such as in dense cover, the head is lifted up about an inch. The Scope-Site mount is available with either an adjustable or a fixed rear sight. Both have white-outlined notches. The front sight post is blaze orange. The Millett Scope-Site is more expensive than some mounts, but you're buying both rings and sights.

Since writing the section on chronographs, I have tested the new Oehler Model 35P, complete with Skyscreen III system. The 35P has an optional printer that uses ordinary adding machine tape. The 35P is unique in that it prints out two readings on the tape, along with the shot number. One reading is the primary velocity, the other a proof velocity, which I will explain later. At the end of a string of shots, the summary button is pushed, and the 35P prints out the highest velocity, lowest velocity, total spread, average velocity and the standard deviation. An editing mode provides a replay of the velocities in the group and allows the shooter to omit one or more velocities from the summary.

The Skyscreen III system uses three triangles (called channels) spaced four feet apart with the proof screen in dead center. The first screen is 10 feet from the muzzle on high velocity rifles, so this setup gives an instrumental velocity at 12 feet — 10 to the first screen, and 2 feet to the halfway point in the screen spacing.

The primary channel velocity is the reading over the total screen spacing of four feet. The proof channel reading is taken from the middle screen to the end screen, so will differ slightly from the primary velocity.

Most shooters are familiar with the average velocity, which is about the halfway point in the velocity readings. However, the average velocity tells nothing about the uniformity of loads. It does not tell how much the velocity readings ranged above and below the average. This is where standard deviation comes in. Dr. Oehler says the standard deviation is a number which describes uniformity. The smaller the standard deviation, the more uniform the velocity. Zero would mean that all readings were the same. A standard deviation of 9, as shown on the nearby sample, means you expect two-thirds of the individual velocities to be within 9 fps of the average. That's definite proof of unifority. Standard deviation is the best measurement of uniformity, and it fits recognized statistical procedures and equations.

Instead of ending my book on a high note, by telling you about the 235-yard shot I made on a running deer, say, or about the time I made a double on a rabbit and a grouse that simultaneously came out of a large brushpile, I'll relate several, let's say, "more humiliating experiences." The kind that show our frailties, and prove every one of us is only human. The truth is, there are times we fail miserably. Failure and humiliation are important ingredients in life. Whether we like it or not, we need them, and I have had my share. Although these happened perhaps forty years ago, they haunt me to this very day.

A young fellow and his new wife moved into a farmhouse a few miles from where I lived. I knew him well, but had never met his wife. One snowy evening at the country store he suggested I hunt the next day around his barn and orchard to reduce the rabbit population that had literally wiped out his garden. He said he would be working, but would tell his wife I'd be hunting around the buildings.

My hunting pal Charley and I arrived on a hill above the orchard early the next morning. Luck was with us and a set of fresh tracks led me through the orchard to within twenty feet of the owner's garage. I spotted a rabbit sitting under a small pile of limbs. I told Charley it might be wise to let the wife know we were there, and he agreed. When the door opened, I saw she was an attractive young woman. I explained the situation and she told me her husband had said we'd be there in the morning. I pointed to the brushpile near the garage and explained I hadn't wanted to shoot so close to the house without her being aware of our presence. She told me we could hunt anywhere, and that she hoped we would get several rabbits.

I thanked her profusely and walked off the porch. I went a few yards before it struck me I had broken one of the cardinal rules in sportsmanship. I went back and knocked again.

"I'm sorry I was so thoughtless," I said. "Perhaps you would like to have the rabbit."

"Great," she exclaimed, her smile getting bigger. "The only problem is that I don't know how to clean and skin a rabbit."

"I'll handle that," I assured her.

"Wonderful! Don't shoot it until I get a pan."

As we moved closer to the brushpile, I motioned for her to wait. I loaded my Stevens 20-gauge double and moved forward.

"Okay, Charley, I'll take him from here," I sang out. My voice was clear and filled with assurance. I glanced back at the young lady who was holding a dishpan and wearing that fascinating smile.

Charley booted the brush heap and a blinding streak came out on my side. It was the only time a land animal broke the speed of sound. I fired. Twice. My first shot was five feet in front of the rabbit, and when I tried to correct the error, I poured a load of 6s into a spot the rabbit had already passed. I'm certain a vapor trail lingered over the snow after it vanished.

"You missed," she said, her smile spreading wider and wider.

I was dumbfounded. I had missed two shots at a rabbit running across an open apple orchard. I stammered something about being a little out of practice. She nodded understandingly, but I could see she was biting her lip to keep from bursting into laughter. Charley and I took off for other parts, leaving the young lady holding her empty dishpan.

"Pretty smile hard on shooting eye, wise old hunter said," Charley suggested cautiously.

"Aw, shut up and keep on tramping," I muttered. Right then I vowed deep in my heart that the next time I offered anyone a rabbit, I would have it in my hands . . .dead. I've kept that vow ever since.

Another occasion when I should have remained silent was at a church meeting. A dozen or so men had gathered to discuss some important church business and also to decide what the main meal would consist of at our regular monthly Layman's Organization meeting, only a week away. Everyone turned thumbs down to hamburgers, fried chicken, and spaghetti and meat balls; they wanted something different. After some thought, I whispered a few words to the minister.

He turned to the group. "We have a very generous offer this evening, gentlemen. Don Lewis had kindly consented to furnish us with some rabbits and grouse if we can get someone to cook them."

"Gus will do it, won't you, Gus?" somebody spoke out.

"I sure will," Gus agreed. "And I'll make some special sauce to pour over the grouse. You fellows will really go for it."

I left the little meeting basking in the air of goodwill which grew out of my offer. I graciously accepted their generous praise for my ability to hunt

and shoot, and even heard them telling the custodian to make certain my plate was at the head of the table along with the minister's. How little it took to bring a moment of joy into the lives of a few men.

I wasn't too worried when Wednesday rolled around and I hadn't connected on either a rabbit or a grouse. Thursday was Thanksgiving, so I could put in a full day afield. But I didn't disturb a hair or a feather on that holiday, and I began to get apprehensive. All I had to show for me efforts was a pocketful of empty shotshells.

Friday morning found me entering the grouse woods at the opening minute. I got two quick shots but didn't connect. By noontime, I was desperate. I tramped every place I could think of for rabbits, but when I did get an occasional one out, I either missed or didn't get a shot. Around 4:30, I managed to roll a rabbit on the second shot. When it began to crawl, I laid down my shotgun and ran toward it. I soon realized that was a mistake for the rabbit had picked up speed and was outdistancing me. I was in high gear, going down through an uncut hayfield in hot pursuit of the rabbit, when I saw another hunter.

"Stop that rabbit," I yelled.

He must have thought I was some kind of kook, running through the fields without a gun yelling, "Stop that rabbit." I didn't know it then, but the rabbit had ducked into a chuck hole long before it got near the hunter. I didn't know exactly what to say, and he studied me with a strange look on his face. I think I could have sent him home talking to himself by telling him my dog was on top of the hill with the shotgun, waiting for me to circle the rabbit.

By quitting time, I didn't have a single thing to show for almost five days of hunting.

As we sat down to burned hamburgers at the meeting, I was grateful the minister didn't mention Gus's grouse sauce when he returned Thanks.

Thanks for reading this book, and a double thanks for sticking with us through twenty-five years of *Game News* gun columns. Helen and I are grateful to each and every one of you.

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experiences along with the help, advice and encouragement I received from firearm manufacturers, reloading companies, optical firms, gunsmiths and countless letters from dedicated *Game News* readers.

I like to think this book will be not only a source of reference but also a source of enjoyment. If its pages become tattered and soiled from use, my efforts will not have been in vain; I couldn't be paid a higher compliment. Good reading, and God bless all of you.

On the front cover, I'm carrying a M700 Remington Mountain Rifle in 280 caliber with a 2½-10x Bausch & Lomb scope in Millett mounts and a Cobra sling from Uncle Mike's. Weather in Pennsylvania's deer season is usually bad, so I'm wearing a Remington 4-Way Parka and Still Hunter pants.

On the back cover photo, taken on a squirrel hunt, Helen is using a M77/22 Ruger with Leupold M8-8x, and I have a M39A Marlin with a 6x Redfield Five-Star.

My brother Dan and I were fishing along the Allegheny River. Helen and her father were plugging for bass, and stopped to talk. When the conversation drifted from fishing to hunting, Helen's dad remarked how hard his Ithaca 12-gauge kicked. He claimed it nearly knocked Helen down when she shot at squirrels. When I learned the attractive gal behind the oars was Helen and also a squirrel hunter, I forgot about fishing.

Over the past 48 years, we have found squirrel hunting with the 22 rimfire to be a challenging sport. We are still avid squirrel hunters. Helen has hunted with many rimfires, but in recent years, she has used a Ruger 77/22 equipped with a Leupold M8-8x scope and Uncle Mike's sling.

As a gunwriter, I have run the gamut of rimfires from factory models to custom outfits. Maybe I can't have a favorite, but I have a great deal of admiration for the Marlin 39A lever action. Countless young hunters cut their shooting teeth with this famous model. As it approaches its 100th birthday (it's the oldest shoulder gun still in regular production anywhere in the world), the Model 39A deserves to be recognized for its contribution to the American shooting scene. It is an All-American and an integral part of our heritage. Mine is fitted with an Uncle Mike's sling and a Five-Star Redfield 6x factory focused for 50 yards.